A PENTON PUBLICATION U.S. $10.00

ELECTRONIC DESIGN

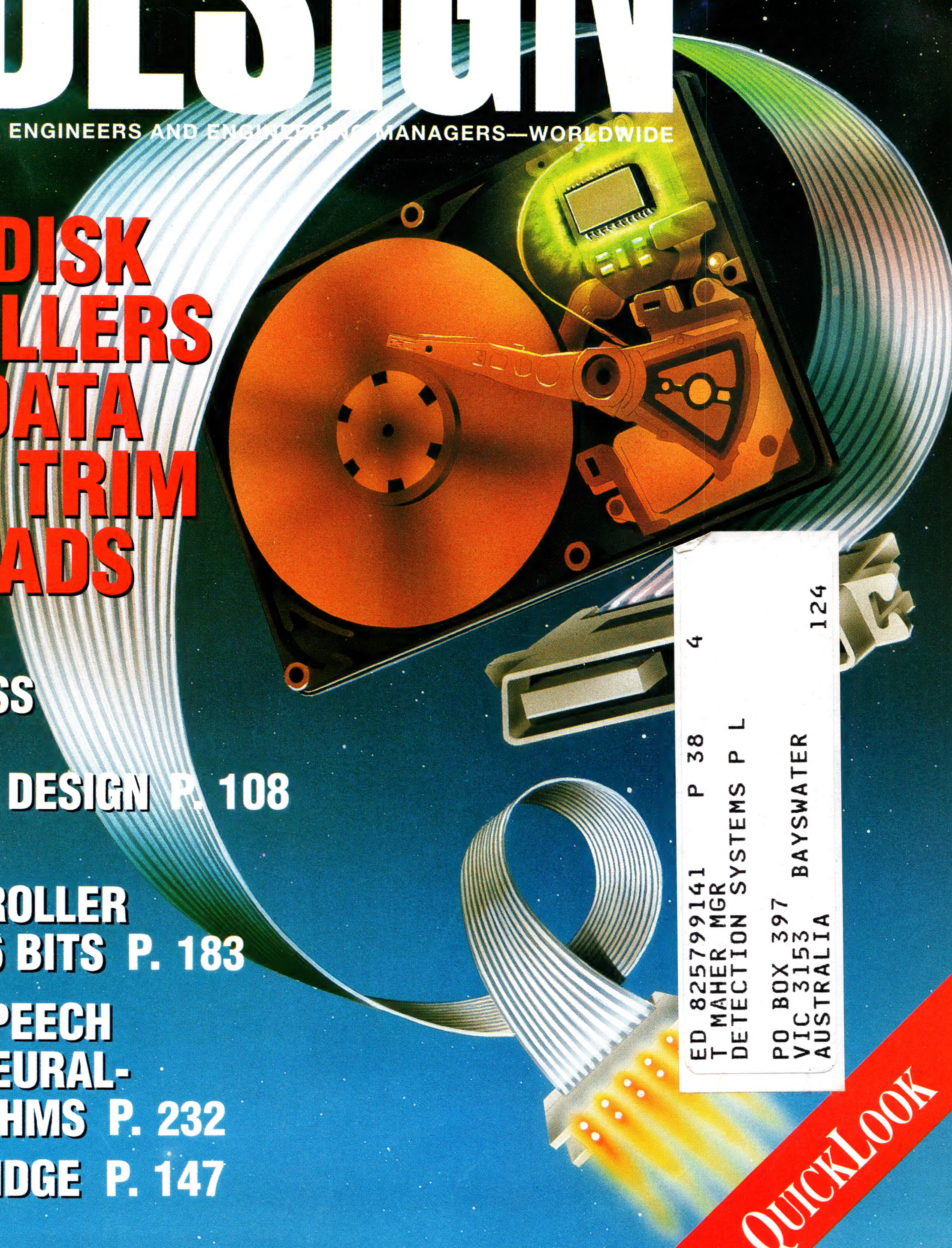
5 DEC 1994

SEPTEMBER 19, 1994

FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

COVER STORY P. 85

SMART DISK CONTROLLERS SPEED DATA MOVES, TRIM OVERHEADS



- TECHNIQUES HELP HARNESS THE POWER OF VHDL PLD DESIGN P. 108
- 80C51–TYPE MICROCONTROLLER JUMPS TO 16 BITS P. 183
- LOW-COST SPEECH CHIP USES NEURAL-NET ALGORITHMS P. 232
- PEASE PORRIDGE P. 147

ED 825799141 P 38 4
T MAHER MGR
DETECTION SYSTEMS P L
PO BOX 397
VIC 3153 BAYSWATER 124
AUSTRALIA

QUICKLOOK

Start with OrCAD. Finish with OrCAD.

Schematics. PCB Layouts. FPGAs. OrCAD has what it takes to get the job done. Fast.

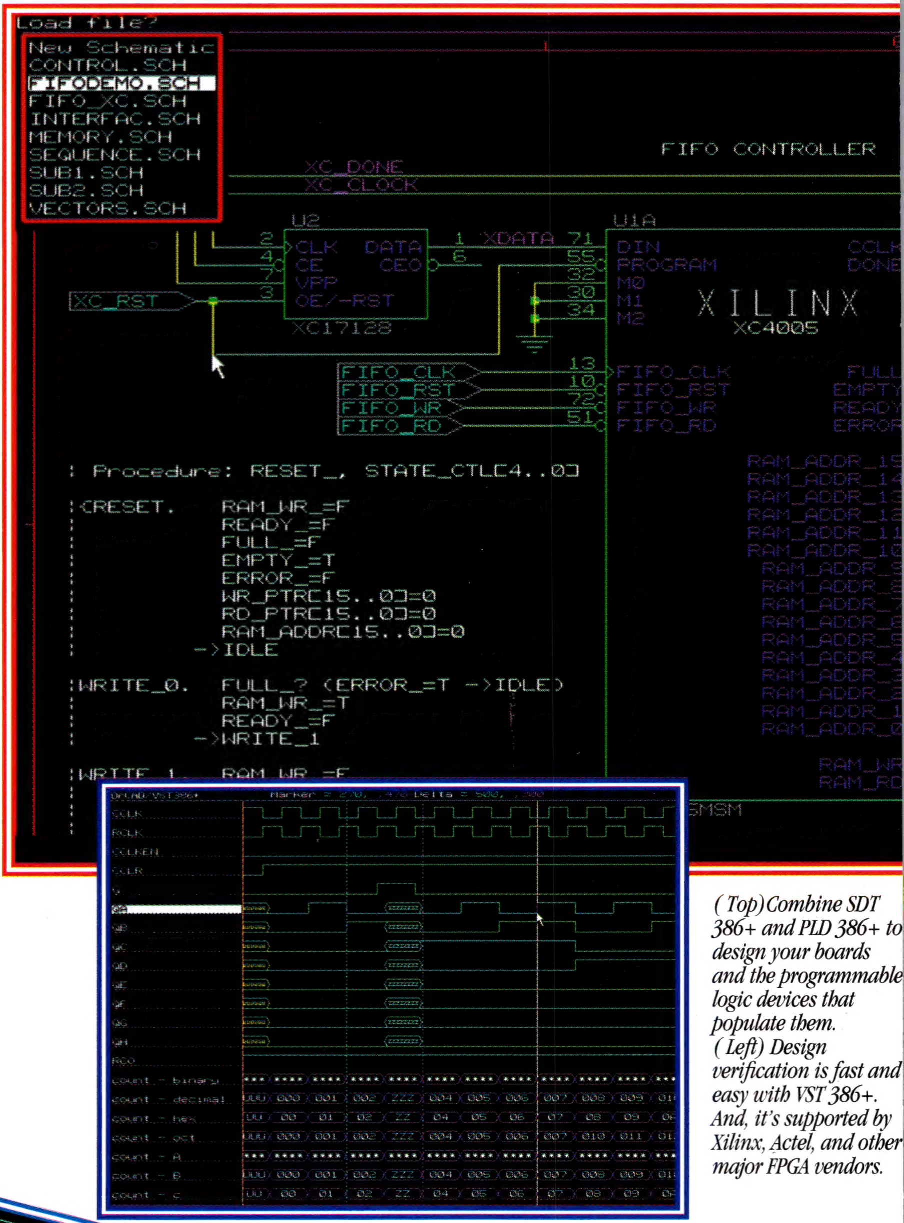
OrCAD delivers the complete solution for all board, PLD and FPGA designs. Over the years more than 90,000 engineers have used OrCAD's design tools, making them the world's most popular EDA software. Today, OrCAD's enhanced 386+ software quickly handles your most complex designs, and gives you the fastest graphics of any PCB design tool. What's more, you can now design with OrCAD in a DOS session under Microsoft Windows. All this, plus a one-year product warranty, makes OrCAD the best value in PCB design solutions. From Start to Finish.

Speed your boards from Concept to Production.

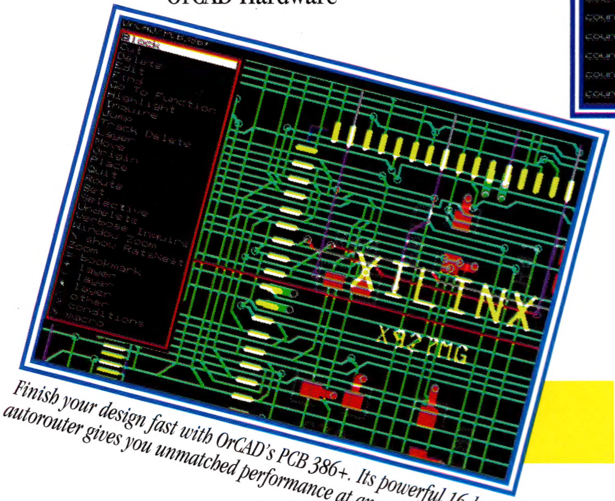
Start with the enormous capacity of OrCAD's SDT 386+ schematic capture tool. Couple it with our powerful PCB 386+ layout solution to reduce your design cycle time. PCB 386+ gives you superior functionality, with over 1,000 footprints, automatic footprint generation, and on-line all object editing. And PCB 386+ boasts an embedded, 100% completion autorouter that tops all other PC-based solutions. OrCAD delivers all this, plus, you'll finish your design with complete manufacturing output.

Target virtually any FPGA device with OrCAD's new PLD 386+.

Capture your design in OrCAD schematics, OrCAD Hardware Description Language, or both. The multi-level synthesis capability of OrCAD's PLD 386+ 2.00 rapidly compiles your largest FPGA designs. And it delivers greatly expanded device support, including: Actel, Intel Flexlogic, Xilinx 2000, Xilinx 3000, Xilinx 4000, Xilinx EPLDs, AMD MACH, AMD MACHXL, Lattice PLSI, Texas Instruments, and many others. Finish your job with speed and accuracy using VST 386+ to verify the timing of your placed and routed design.


```
Load file?
New Schematic
CONTROL.SCH
FIFODEMO.SCH
FIFO_XC.SCH
INTERFAC.SCH
MEMORY.SCH
SEQUENCE.SCH
SUB1.SCH
SUB2.SCH
VECTORS.SCH

: Procedure: RESET_, STATE_CTL[4..0]

:[RESET.      RAM_WR_=F
:             READY_=F
:             FULL_=F
:             EMPTY_=T
:             ERROR_=F
:             WR_PTR[15..0]=0
:             RD_PTR[15..0]=0
:             RAM_ADDR[15..0]=0
           ->IDLE

:WRITE_0.     FULL_? (ERROR_=T ->IDLE)
:             RAM_WR_=T
:             READY_=F
           ->WRITE_1

:WRITE_1.     RAM_WR_=F
```

(Top) Combine SDT 386+ and PLD 386+ to design your boards and the programmable logic devices that populate them. (Left) Design verification is fast and easy with VST 386+. And, it's supported by Xilinx, Actel, and other major FPGA vendors.



Finish your design fast with OrCAD's PCB 386+. Its powerful 16-layer autorouter gives you unmatched performance at an unbeatable price.

Isn't it time you got the whole job done with OrCAD? Call us today at (503) 671-9500 and we'll rush you an OrCAD Demo Disk. Then try our Complete Solution. From Start to Finish.

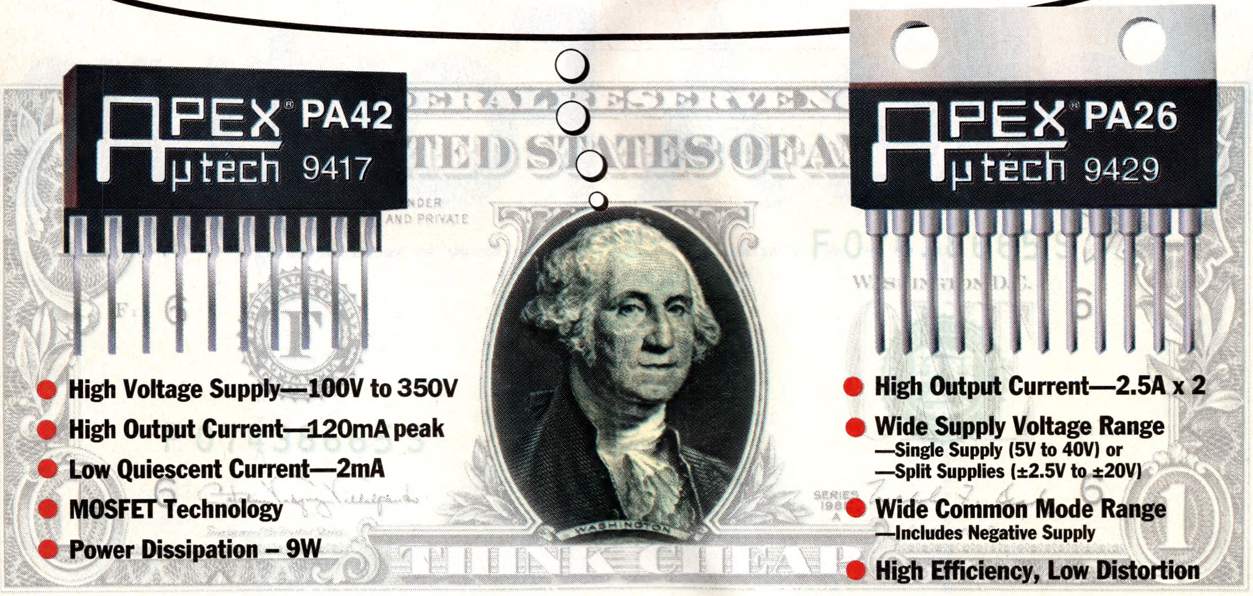
9300 SW Nimbus Ave. • Beaverton, OR 97005 • (503) 671-9500 • (503) 671-9501 - Fax

OrCAD is a registered trademark of OrCAD, Inc. Other brand and product names are trademarks of their respective owners.

READER SERVICE 192

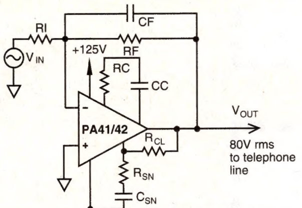
OrCAD®

Big performance? Small Price? Think Apex.

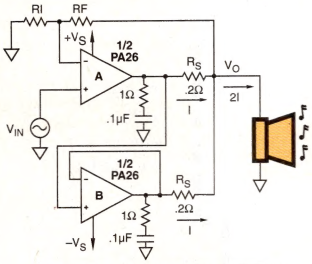


- High Voltage Supply—100V to 350V
- High Output Current—120mA peak
- Low Quiescent Current—2mA
- MOSFET Technology
- Power Dissipation – 9W

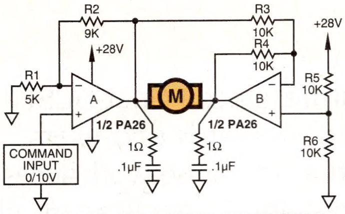
- High Output Current—2.5A x 2
- Wide Supply Voltage Range
  - —Single Supply (5V to 40V) or
  - —Split Supplies (±2.5V to ±20V)
- Wide Common Mode Range
  - —Includes Negative Supply
- High Efficiency, Low Distortion



TELEPHONE LINE RING GENERATOR



5A AUDIO PARALLEL CONNECTION



BIDIRECTIONAL SMALL MOTOR DRIVE

Think Apex Microtechnology if you're looking for amplifiers that deliver big on performance at a price you can afford.

The **PA26** puts two 2.5A rated power amplifiers on a single die, in a single 12-pin inline package. Priced at **$3.45** in 10K pieces, the **PA26** can operate off a wide supply range of 5V to 40V. The **PA42** operates on 100 to 350 volts rail-to-rail with 120mA peak of output current. Housed in a 10-pin SIP, the **PA42** is priced **$13.60** in 10K piece quantities.

KEY FEATURES/KEY SPECIFICATIONS

Part #	V_{SS}	I_O	V_{CM}	V_{SAT}	PKG	$/10K
PA26	5V-40V	2.5A x 2	$-V_S-.3V$	1.8V @ 1.0A	SIP[1]	$3.45
PA21M[2]	5V-40V	2.5A x 2	$-V_S-.3V$	3.5V @ 2.A	TO-3[1]	$39.54
PA42	100V-350V	120mA	$\pm V_S-12V$	10V @ 40mA	SIP[1]	$13.60
PA41M[2]	100V-350V	120mA	$\pm V_S-12V$	10V @ 40mA	TO-3[1]	$46.62

[1] The TO-3 is a hermetic package; the SIP is a non-hermetic package

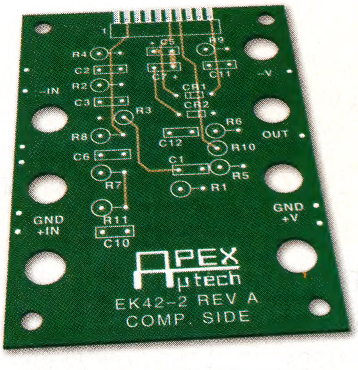
[2] "M" designates hi-rel military grade

Hi-Rel Grade, Hermetic Package Versions Available

For more demanding applications, Apex offers the **PA21M (PA26)** and the **PA41M (PA42)**. Both are housed in hermetically sealed TO-3 packages and tested over the full military case temp range of –55°C to +125°C.

Free Data Book and Application Notes

Information on the **PA26, PA42, PA21M** and **PA41M** is included in the new 6th edition *Apex DC/DC Converters, Power and HV Amplifiers* data book. Call today for your free copy. **1-800-862-1021.**



Ask about evaluation boards for both the PA26 and PA42.

For Immediate
Product Information
Call **1-800-862-1021**
or FAX **(602) 888-3329**

APEX µtech®
DEDICATED TO EXCELLENCE

APEX MICROTECHNOLOGY CORPORATION
5980 N. SHANNON ROAD, TUCSON, ARIZONA 85741

For Applications
Assistance Call Toll
Free **1-800-862-1021**
Deutschsprachig
0130 81 3599
von 15:00-24:00h G.M.T.

AUSTRALIA, NEW ZEALAND (08) 277 3288 BELGIUM/LUXEMBOURG (323) 458 3003 CANADA (613) 592 9540 DAEHAN MINKUK (02) 745 2761 DANMARK (45) 52 24 4888 DEUTSCHLAND (6172) 5113 ESPAÑA (1) 530 4121 FRANCE (1) 69 07 08 24 HONG KONG 8339013 INDIA (212) 339836 ISRAEL (3) 9345171 ITALIA (2) 6640 0153 NEDERLAND (10) 451 9533 NIPPON (3) 3244-3787 NORGE (2) 50 06 50 ÖSTERREICH (222) 505 15 220 PEOPLES REPUBLIC OF CHINA (86) 500 7788/623 REPUBLIC OF SOUTH AFRICA (021) 23 4943 SCHWEIZ (0049) (6172) 5113 SINGAPORE (65) 741 8966 SVERIGE (8) 795 9650 TAIWAN—REPUBLIC OF CHINA (02) 722 3570 TURKIYE (1) 337 22 45 UNITED KINGDOM (0844) 278781

Circle 81 for U.S. response
Circle 82 for response outside U.S.

How AMD He
Make A Fortune

Typical Ethernet adapter card: 4 x 6 inches.

Typical SCSI adapter card: 4 x 7 inches.

Everyone could use some extra space. And that's exactly what Compaq® offers end-users in their new Deskpro® XL. All with the help of AMD,® of course.

AMD's new PCnet™-SCSI controller enabled Compaq's designers to create a high-performance, plug-and-play PC with 32-bit Ethernet and SCSI on the motherboard—eliminating the need for separate Ethernet and SCSI adapter cards.

AMD's PCnet-SCSI chip puts Ethernet and SCSI capabilities right on the motherboard of the new Compaq Deskpro XL.

Your next PC design can have an equally lucrative future, since PCnet-SCSI supports the standards end-users demand: Ethernet for network access. SCSI for peripherals in applications like multimedia. And PCI, the leading high-speed bus architecture. It even comes with a complete selection of Network Operating System and peripheral drivers.

PCnet-SCSI covers only 7.5 square inches of motherboard real estate and takes only one PCI load. Which leaves plenty of PCI loads

One AMD Place, P.O. Box 3453, Sunnyvale, CA 94088. ©1994 Advanced Micro Devices, Inc. PCnet is a trademark. AMD and the AMD logo are registered trademarks of Advanced Micro Devices, Inc. Compaq and Deskpro are registered trademarks of Compaq Computer Corporation. Other product or brand names mentioned are property of their respective holders.

ped Compaq In Real Estate.

AMD's PCnet-SCSI controller: 1 1/8 x 1 1/8 inches.

and open slots for future upgrades. So there's always room for expansion.

What's more, PCnet-SCSI is software and pin-compatible with other members of the PCnet family. So you can configure your systems to offer either Ethernet, SCSI, or both. All in one design.

Best of all, you can add all this functionality for less than $50—compared with a major investment in adapter cards, installation, and support.

For more information on PCnet-SCSI and the entire PCnet family, contact your local AMD sales office listed below. Because with the right connections, you can make a fortune, too.

Ask for Literature Pack 19R.

Advanced Micro Devices

For more information on PCnet-SCSI, contact your local AMD sales office or sales representative. International Sales Offices: Antwerpen (03) 248 43 00; Frankfurt area (06172) 9267-0; Hong Kong 86 54 525; London area (0483) 740 440; Manchester area (0925) 830 380; Milano (02) 339 05 41; München (089) 45053-0; Osaka (06) 243 32 50; Paris (1) 49 75 10 10; Seoul (02) 784 0030; Singapore (65) 348 11 88; Stockholm (08) 98 61 80; Taipei (02) 715 35 36; Tokyo (03) 334 67 550.

RF TRANSFORMERS

Over 80 off-the-shelf models...
3KHz- 2000MHz from **$1⁹⁵**

Having difficulty locating RF or pulse transformers with low droop, fast risetime or a particular impedance ratio over a specified frequency range?.... Mini-Circuits offers a solution.

Choose impedance ratios from 1:1 to 36:1, in connector, TO-, flatpack, surface-mount, or pin versions (plastic or metal case built to meet MIL-T-21038 and MIL-T-55631 requirements*). Coaxial connector models are offered with 50 and 75 ohm impedance; BNC standard, other types on request.

Ultra-wideband response achieves low droop and fast risetime for pulse applications. Ratings up to 1000M ohms insulation resistance and up to 1000V dielectric voltage. For wide dynamic range applications involving up to 100mA primary current, use the T-H series. Fully detailed data appear in our 740-pg RF/IF Designer's Handbook.

Need units in a hurry?...all models are covered by our exclusive one-week shipment guarantee.
Only from Mini-Circuits.

*units are not QPL listed.

Mini-Circuits®

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

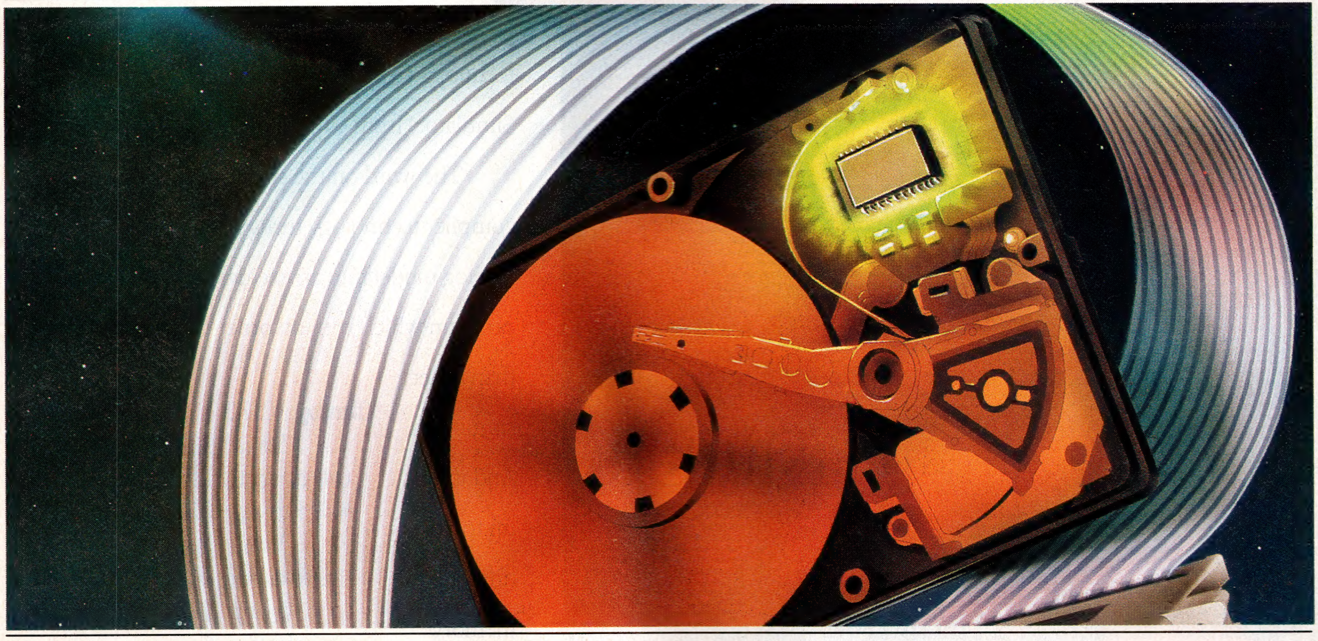
CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

F 71 Rev F

READER SERVICE 114

SEPTEMBER 19, 1994 VOL. 42, NO. 19

ELECTRONIC DESIGN



TECHNOLOGY ANALYSIS

WESCON/94 CONFRONTS INDUSTRY ISSUES . . . 63
As technology continues to reshape the electronics world, designers have to work harder to keep up. Wescon and Idea/Microeletronics try to help.

COVER FEATURE/ SPECIAL REPORT

SMART CONTROLLERS SPEED DATA MOVES, TRIM OVERHEADS . . . 85
Enhanced IDE and SCSI controllers improve system throughputs with more intelligence, faster data rates, and new features.

DESIGN APPLICATIONS

HARNESS THE POWER OF VHDL FOR PLD DESIGN . . . 108
Tips and techniques help VHDL newcomers avoid common pitfalls and make intelligent use of the language.

PRODUCT INNOVATIONS

BASE CELL DESIGN SPAWNS ADVANCED ARRAYS . . . 178
Fourth-generation CMOS architecture offers increased density and higher routing efficiencies.

80C51 MICROCONTROLLER JUMPS TO 16 BITS . . . 180
Enhanced microcontroller architecture maintains backward compatibility while drastically improving performance.

CPLD, FPGA MODELS SPEED SYSTEM DESIGN . . . 183
Improved model technology and a debugging tool suite accelerate verification of programmable logic in a board or system.

CONTROLLER IC SIMPLIFIES REMOTE NETWORKING . . . 189
First silicon implementation of point-to-point protocol to expedite advanced remote networking equipment.

ELECTRONIC DESIGN (USPS 172-080; ISSN 0013-4872) is published twice monthly except for 3 issues in May and 3 issues in October by Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543. Paid rates for a one year subscription are as follows: $105 U.S., $185 Canada, $210 Mexico, $255 International. Second-class postage paid at Cleveland, OH, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204. Printed in U.S.A. Title registered in U.S. Patent Office. Copyright © 1994 by Penton Publishing Inc. All rights reserved. The contents of this publication may not be reproduced in whole or in part without the consent of the copyright owner. For subscriber change of address and subscription inquiries, call (216) 696-7000. Mail your subscription requests to: Penton Publishing Subscription Lockbox, P.O. Box 96732, Chicago, IL 60693.
POSTMASTER: Please send change of address to ELECTRONIC DESIGN, Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543.

“Chronologic’s second generation

Verilog technology allows us to

leverage our investment

in the Verilog-HDL. With VCS, our

regression tests are now completed in

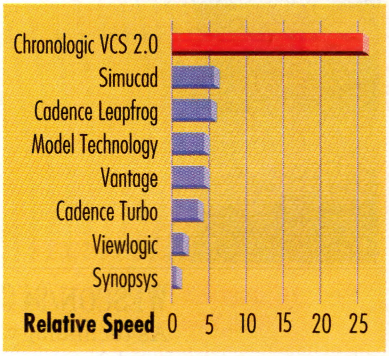
days versus weeks.”

Anant Agrawal
Director of VLSI II
Sparc Technology Business
Sun Microsystems, Inc.

VERY FAST VERILOG

Sun Microsystems. Silicon Graphics. PowerHouse Systems. All these leaders run the Verilog-HDL simulation technology leader: VCS (Verilog® Compiled Simulator) from Chronologic Simulation.

The word on the street? Our advanced compiler technology turns your synthesizable Verilog model into an executable simulation program which runs an order of magnitude faster than other simulators. And it uses up to 20 times less memory. Your simulations now take minutes instead of hours; hours instead of days.



*Independent benchmarks confirm that VCS is simply the fastest HDL simulator available. No other simulator even comes close.**

VCS offers full capabilities from model development, interactive debugging and regression testing, all the way to gate-level timing simulation. The speed and memory advantages of VCS even enhances the design process from beginning to end.

Technology from Chronologic Simulation runs with some very fast company. Call 1-800-837-4564 or Fax 415-965-2705 to find out what VCS can do for you. In Europe, call (44) 844 214367 or Fax (44) 844 214365. Our e-mail address is: info@chronologic.com.

CHRONOLOGIC SIMULATION
A VIEWLogic Company

VCS is a trademark of Chronologic Simulation. Verilog and Verilog-XL are registered trademarks of Cadence Design Systems, Inc. All other brand or product names are trademarks or registered trademarks of their respective owners. *Graph source: Independent comparison of HDL Simulators, EE Times, June 14, 1993. Electronics Times, September 2, 1993.

READER SERVICE 259

ELECTRONIC DESIGN

40 YEARS AGO IN ELECTRONIC DESIGN . . . 8
Vacuum tube voltmeter has wide frequency range; Editorial: The quiet revolution

UPCOMING MEETINGS . . . 12,172

EDITORIAL . . . 16
Setting it straight

TECHNOLOGY BRIEFING . . . 20
Sensors seek better fab technology

TECHNOLOGY NEWSLETTER . . . 27

TECHNOLOGY ADVANCES . . . 45
- Laser-scanning system offers real-time imaging and review of wafer defects
- Multilevel charge-value sensing scheme doubles flash-memory storage density
- Are 100-GHz-ft. silicon-germanium HBTs for real? Find out at the BCTM
- Ceramic substrates and PLAs key to low-cost and dense function modules
- VXIplug&play to rescue test-system integrators
- Symbolic logic representation speeds design verification
- VITA and MMG join forces to promote PCI mezzanine card

IDEAS FOR DESIGN . . . 135
- Very efficient solenoid driver
- Detect frequency with LM556 timer
- Protect driver from overload
- Spare channel nets 12-V supply

QUICK LOOK . . . 141
- My View . . . Cleveland, cards, and golf
- *The Cache Memory Book* reviewed
- Perspectives on time-to-market
- Eye on ISO 9000

PEASE PORRIDGE . . . 147
Bob's Mailbox

COMPUTER SYSTEMS SPECIAL SECTION
PC Graphics Watch . . . 151
Bandwidth must meet rising demands . . . 153
System Design News . . . 160
System Design Products . . . 165

PRODUCT NEWSLETTER . . . 196

NEW PRODUCTS
Packaging . . . 200
Components . . . 201
Communications . . . 206
CAE . . . 210
Software . . . 214
Power . . . 218
Computer Boards . . . 220
Instruments . . . 222
Analog . . . 225
Computers & Peripherals . . . 230
Digital ICs . . . 234

READERS' COMMENTS . . . 244

NEW LITERATURE . . . 245

INDEX OF ADVERTISERS . . . 252

READER SERVICE CARD . . . 253A-D

COMING NEXT ISSUE

- Special Report on pressure sensors
- What's new in PCMCIA cards and mass storage
- Multimedia: MPEG swims into the mainstream
- Preview of the International Test Conference
- Tips on using FPGAs to design network systems
- PLUS:

Pease Porridge
Ideas for Design
QuickLook

Jesse H. Neal Editorial Achievement Awards:
1967 First Place Award
1968 First Place Award
1972 Certificate of Merit
1975 Two Certificates of Merit
1976 Certificate of Merit
1978 Certificate of Merit
1980 Certificate of Merit
1986 First Place Award
1989 Certificate of Merit
1992 Certificate of Merit

Permission is granted to users registered with the Copyright Clearance Center Inc. (CCC) to photocopy any article, with the exception of those for which separate copyright ownership is indicated on the first page of the article, provided that a base fee of $2 per copy of the article plus $1.00 per page is paid directly to the CCC, 222 Rosewood Drive, Danvers, MA 01923 (Code No. 0013-4872/94 $2.00 +1.00). (Can. GST #R126431964). Canada Post International Publications Mail (Canadian Distribution Sales Agreement Number 344117). Copying done for other than personal or internal reference use without the express permission of Penton Publishing, Inc. is prohibited. Requests for special permission or bulk orders should be addressed to the editor.

FAST CMOS FLASH A/Ds

Micro Networks Can Solve Your Application Puzzle with the Industry's Fastest CMOS Flash A/D Converters.

MN5909
100MHz
34dB SINAD
43dB SFDR
200mW Power

MN5906
50MHz
35dB SINAD
44dB SFDR
225mW Power

FEATURES
- 6-Bit Resolution
- +5V Supply Operation
- T/H Not Required
- DIP and SOIC Packaging
- Commercial, Industrial and Military Models

Call or FAX for FREE Samples or Product and Applications Information for Our CMOS Flash A/D Converters.

Maximum Performance Minimum Power

Micro Networks is an ISO-9001 "Registered Firm"

nsai
I.S./ISO 9001/EN 29001

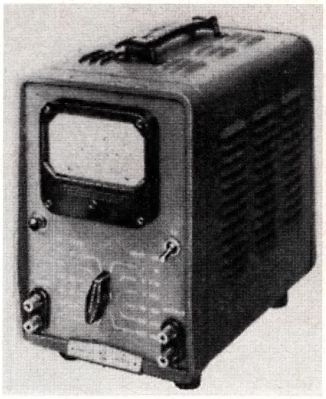
MICRO NETWORKS
324 Clark Street
Worcester, MA 01606
Tel (508) 852-5400
Fax (508) 853-8296

READER SERVICE 109

ELECTRONIC DESIGN 40 YEARS AGO

Vacuum tube voltmeter has wide frequency range

The Model 400D high accuracy vacuum tube voltmeter covers all frequencies from 10cy to 4Mc. It measures voltages from 0.1mv to 300v, and is accurate to within 2% up to 1 megohm. Input impedance is 10 megohms. The instrument has a new amplifier circuit providing approximately 56db of feedback in mid-range for high stability and freedom from calibration changes caused by external conditions. Ranges are selected on a front panel switch that changes sensitivity in accurate 10db steps. This switch plus calibration of the 4" meter directly in decibels means direct readings are available without calculation or conversion between –72dbm and +52dbm. Readings are always in the upper part of the scale where maximum accuracy is obtained. In addition to measuring gain, response, and output level, the voltmeter measures hum and noise directly, serves as an audio levelmeter and high gain broad band amplifier, detects nulls, monitors waveforms, and measures coil "Q." Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.*(Electronic Design, September 1954, p. 63.)*



This meter had an impressive pedigree. HP co-founder David Packard actually worked on the design of the first voltmeter in the series, the 400A. The version covered here, the 400D, had two other test and measurement pioneers on its design team: Bernard M. (Barney) Oliver, who was later Vice President for Research and Development at Hewlett-Packard, and John Zevenbergen, who subsequently moved to the Seattle area to join John Fluke Manufacturing Co., where he eventually became the company's president.—SS

Editorial: The Quiet Revolution

For some time now, a slow steady change has been taking place in electronic devices as a result of two relatively recent developments in the field. Both are so basic that their adoption is causing a "quiet revolution" in the electronic industries. We are, of course, referring to transistors and printed circuits.

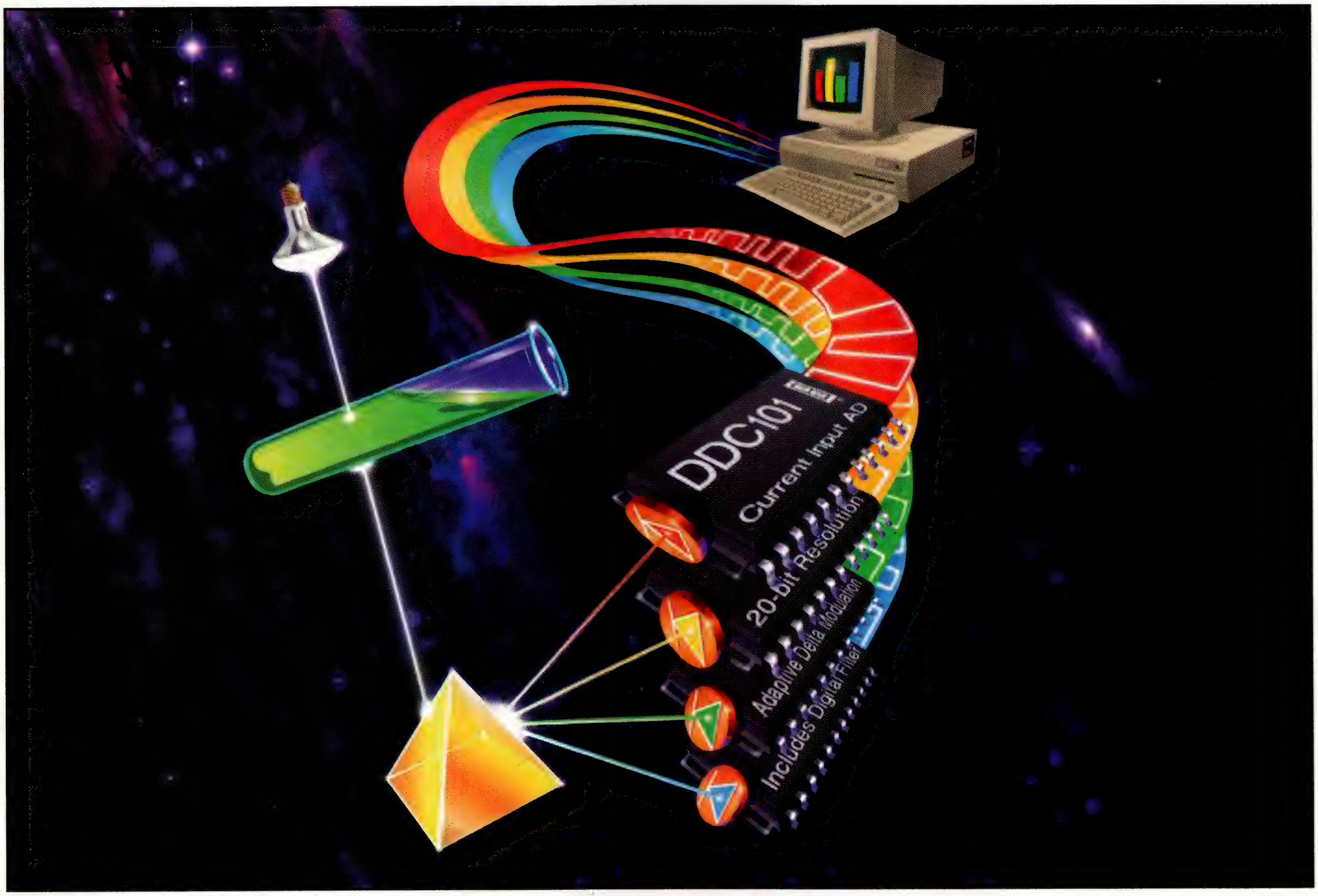
Of these two developments, the transistor has produced the lesser impact as far as commercial applications are concerned. Cost, availability, limited frequency range, and lack of standardization are some of the reasons why many designers have been reluctant to use transistors. Through intensive research and development programs on the part of transistor manufacturers, all of these deterring factors are rapidly being corrected. Before too long we should see many new commercial applications of transistors on the market.

Printed circuit techniques, on the other hand, have gained a fair amount of acceptance among designers. Test instruments, small phonograph amplifiers, larger audio amplifiers, a-m/f-m receivers, computers, and TV receivers are some of the places where printed circuit techniques are being employed. One TV set manufacturer has designed his set using sectionalized printed circuits throughout, and a French TV receiver has been publicized that has the entire chassis printed on a single sheet of laminate material.

This revolution, though quiet in the sense that not much publicity has been given to commercial applications, is none the less real. It is up to the designer to make his company aware of this trend and to lead management out of its interior by thoroughly investigating the possibilities of these developments for his particular product line.*(Electronic Design, September 1954, p. 4.)*

It may seem odd to compare transistors with pc-board technology. However, this editorial accurately sized up the situation at that time: 1954-vintage transistors were little more than a promise while pc boards were already revolutionizing electronics manufacturing. Of course, it wasn't long before the transistor revolution moved out of its "quiet" state and produced a boom that still resounds throughout the industry.—SS

The World's Most Accurate A/D for Low Level Signals



20-Bit Photo Sensor A/D

DDC101 is a 20-bit, current input A/D converter designed for direct connection to photodiodes and other low level current output devices. It replaces an amplifier circuit, programmable-gain amplifier, and high resolution A/D converter—all on a single, monolithic chip. Use **DDC101** for photosensor digitization, medical analyzers, data acquisition systems, chemical analyzers, and infrared pyrometry. It's the closest thing to digitized light!

Light Years Ahead Architecture

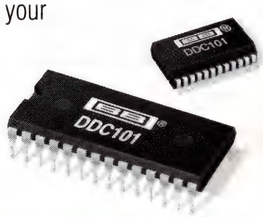
DDC101's patented delta modulation architecture accurately digitizes a current signal. Using digital integration, oversampling, digital filters, and DSP, it improves noise and linearity as the input level decreases. Or, as the input signal gets smaller and smaller, **DDC101** gets better and better—with an input signal of 0.1% full scale the maximum linearity error is only 0.00028% FSR! Its conversion rate is up to 15kHz. It is the world's most accurate A/D for low level signals!

DDC101 Key Specifications

- Resolution.......20-bit
- Noise.......1.6ppm, rms
- Conversion rate.......up to 15kHz
- Accuracy at low level.......2.5ppm of FSR, (max)
- Power dissipation.......170mW
- Digital error correction.......CDS
- Packages.......28-pin DIP and 24-pin SOIC
- Demo Board with part available

See the Light...FREE Samples!

Try the light years ahead solution! Get your **FREE** sample and detailed data sheet by FAXing **1-602-741-3895.** Or, contact your local sales representative for more information.



BURR - BROWN
ISO9001
CERTIFIED

BURR - BROWN®

International Subsidiary Offices: Austria (43) 1 602 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 3465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

CIRCLE 83 FOR U.S. RESPONSE CIRCLE 84 FOR RESPONSE OUTSIDE THE U.S.

SCSI PORTABLE ANALYZER / EMULATOR

- SCSI 1&2
- SCSI 3 Parallel
- FAST & WIDE
- SCSI Initiator Emulator
- Single-Ended or Differential (optional)
- Tracing over 10Mhz with 20 nsec time stamp resolution
- Applications: development, production, field service

☎ (415)322-5322 FAX: (415)322-0455
115 Constitution Dr., Menlo Park, California 94025 USA

BASICS OF SCSI BOOK AVAILABLE FREE!

ANCOT CORPORATION

READER SERVICE 80

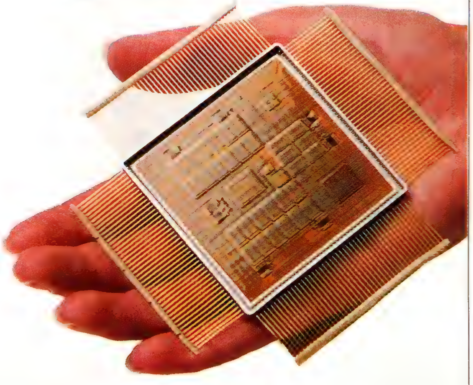
MCM DESIGN CENTER™

Art-to-Part Multi-Chip Module Design & Fabrication

- Achieve Time-To-Market Within Budget
- Select The Optimum Technology — MCM-C, MCM-D or MCM-L
- Access the Best MCM Foundries
- Assure Known-Good-Die

Convert Your Products To High Performance MCM's

Talk To An MCM Designer Today!
Call
505-768-7627



MCM DESIGN CENTER
1720 Randolph Road S.E.
Albuquerque, New Mexico
USA, 87106
505-768-7601 (Fax)

READER SERVICE 257

ELECTRONIC DESIGN

Editor-in-Chief: Jack Shandle

Executive Editor: Roger Allan

Managing Editor: Bob Milne

Senior Editors: Frank Goodenough, John Novellino

Technology Editors:
Analog & Power: Frank Goodenough
Communications: Lee Goldberg
Components & Packaging: David Maliniak
Computer-Aided Engineering: Lisa Maliniak
Computer Systems: Richard Nass
Semiconductors: Dave Bursky (San Jose)
Software: Sherrie Van Tyle
Test & Measurement: John Novellino

News Editor: Clifford Meth

Field Correspondents:
West Coast Executive Editor:
Dave Bursky (San Jose)
Western Editor:
Cheryl J. Ajluni (San Jose)
To contact, call or write:
2025 Gateway Place, Suite 354
San Jose, CA 95110
(408) 441-0550

London: Peter Fletcher
To contact, call or write:
611 Route 46 West
Hasbrouck Heights, NJ 07604
(201) 393-6262 or (201) 393-6270
Fax (201) 393-0204

Chief Copy Editor: Roger Engelke Jr.

Contributing Editors:
Ron Kmetovicz, Robert A. Pease

Editorial Production Manager:
Pat A. Boselli
Production Coordinator: Wayne M. Morris

Group Art Director: Peter K. Jeziorski

Associate Art Director: Tony Vitolo

Staff Artist: Tom Pennella, Linda Gravell

Editorial Support Supervisor:
Mary James

Editorial Assistant: Ann Kunzweiler

Editorial Assistant: Bradie Nieto

Vice President-Editorial: Perry Pascarella

Advertising Production:
(201) 393-6093 or Fax (201) 393-0410

Production Manager: Mike McCabe
Assistant Production Manager:
Eileen Slavinsky
Production Assistants:
Joyce Borer, Barbara Riley

Circulation Manager: Susan Brown

Reprints: Anne Adams
Penton Reprints 1-800-659-1710

Published by Penton Publishing

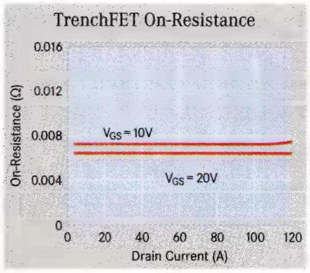
Electronic Design Information Group:

Editorial Director: Stephen E. Scrupski

Publisher: John R. Carroll

Siliconix drives lower on-resistance and incredibly shrinking boards.

Introducing Siliconix's new TrenchFET™ power MOSFETs. Low on-resistance dramatically reduces parts count and increases board reliability.



Thanks to a new process developed and patented by Siliconix, our new family of TrenchFETs feature 8 million cells per square inch and deliver on-resistance as low as 8mΩ with a 60-V breakdown voltage and 175°C maximum junction temperature. The result is fewer parts and smaller, more reliable board designs for automotive applications such as airbags, ABS, power steering, window lifts, motors and fuel pumps.

In addition, these TrenchFET devices provide lower conduction and switching loses, virtually eliminating the need for heatsinks. Siliconix offers five new TrenchFET devices in TO-220 or surface-mount TO-263 (D^{2}PAK) packages and are as cost effective as relays.

New TrenchFETs from Siliconix. They're so power- and cost-efficient, you can satisfy your drive for better, smaller and more reliable board designs. For samples or more information, call us at 1-800-554-5565, ext. 530.

TEMIC

Siliconix, A Member of TEMIC

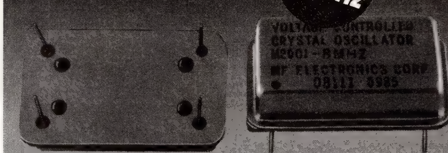
TEMIC is a company of AEG Daimler-Benz Industrie. 2201 Laurelwood Road, Santa Clara, CA 95054 Fax: 408-970-3995.
Members of TEMIC Semiconductors: Telefunken Semiconductors, Siliconix, Matra MHS, Dialog Semiconductor.
TEMIC International Sales: UNITED KINGDOM: 0344-485757. GERMANY: 0310 857 320. FRANCE: 130 60 70 00. ITALY: 02-332 121.
SCANDINAVIA: 08-733 0090. SINGAPORE: 65-788 6668, ext. 249. HONG KONG: 852-3789 789. JAPAN: 3-5562 3321.
TrenchFET is a trademark of Siliconix. ©1994 Siliconix/TEMIC. All rights reserved.

MF ELECTRONICS CORP.

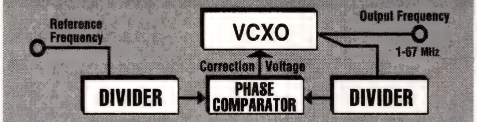
VCXO's and
PHASE-LOCKED-LOOP-VCXO

VCXO's Series M2000
1MHz to 67 Mhz

NEW! 160 MHz



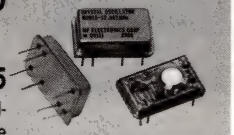
These VCXO's are used to replace a distorted incoming reference signal (e.g. 1.544 MHz, T1), with a stable crystal-controlled signal of the same or any multiple frequency, from 1 to 67 MHz.



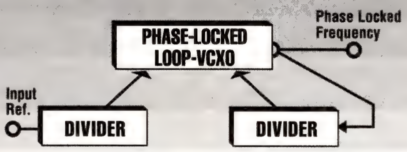
With MF VCXO's, since the specification is computer-tested over the full operating temperatures, you can be assured that the specified frequency- deviation is what you get for capture range.

	Control Voltage	Deviation
M2001	0.3 to 10V	±175 ppm
M2002	0.3 to 4V	± 75 ppm
M2003	0.3 to 10V	±175-300 ppm
M2004	0.3 to 4V	±125 ppm
M2005	1.0 to 4V	± 75-300 ppm
M2006	0 to 5V	±150 ppm
M2007	0.5 to 4.5V	±125-250 ppm

PHASE-LOCKED LOOP-VCXO'S
Series M2010, M2015



This is the complete loop, including the phase-comparator and the VCXO, in just one package. Add the dividers to match the frequencies. Oscillators from 10 to 30MHz.



	Frequency Range
M2010	±125 ppm
M2015	±150 ppm

Headquarters and manufacturing plant: 36,000 sq. feet

MF ELECTRONICS CORP.
10 Commerce Drive
New Rochelle, NY 10801
914-576-6570 Fax: 914-576-6204
▶ CIRCLE 136 • SEE EEM

READER SERVICE 220

UPCOMING MEETINGS

SEPTEMBER

2nd IEEE Workshop on Interactive Voice Technology for Telecommunications Applications, Sept. 26-27. Sumitomo Hall, Kyoto, Japan. Contact Sadaoki Furui, NTT Human Interface Labs, 3-9-11 Midori-cho, Musashino-shi, Tokyo, 180 Japan; 81-422-59-3910; fax 81-422-60-7808.

Information Superhighway Summit/San Jose, Sept. 26-28. Red Lion Hotel, San Jose, CA. Contact Jeff Silha, IDG World Expo, (800) 225-4698 or (508) 820-8628.

WESCON '94-Idea/Microelectronics, Sept. 27-29. Anaheim Convention Center, Anaheim, CA. Contact Joan Carlisle, Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045; (310) 215-3976; fax (310) 641-5117.

3rd International Conference on Universal Personal Communications, Sept. 27-Oct. 1 (ICUPC '94). San Diego, CA. Contact Henry A. Macchio, Hughes Network Systems Inc., 10450 Pacific Center Ct., San Diego, CA 92121; (619) 452-4610; fax (619) 597-8979.

OCTOBER

1994 IEEE International Test Conference (ITC), Oct. 2-6. Sheraton Washington Hotel, Washington D.C. Contact Doris Thomas, International Test Conference, 205 Tennyson Ave., Suite C, Altoona, PA 16602; (814) 941-4666; fax (814) 941-4668.

Antenna Measurement Techniques Symposium '94, Oct. 3-7. Hyatt Regency, Long Beach, CA. Contact James P. McKay, The Aerospace Corp., M1/135, P.O. Box 92957, Los Angeles, CA 90009; (310) 336-1596; fax (310) 336-6225.

1994 7th International Conference on Formal Description Techniques, Oct. 4-7. University of Berne, Switzerland. Contact Dr. Dieter Hogrefe, University of Berne, Langgasstrasse 51, P.O. Box 900, CH-3000, Berne 9, Switzerland; (41)-31-6314994; fax (41)-31-6313965.

Far East Tour 1994, Electronics & Computer Shows, Oct. 4-17. Japan, Taiwan, Hong Kong, Korea, China, Singapore. Contact Ellen Wong, Commerce Tours International Inc., 870 Market St., S San Francisco, CA 94102; (415) 433-3072; fax (415) 433-2820.

CD-ROM Expo/Boston, Oct. 5-7. World Trade Center, Boston, MA. Contact Mitch Hall & Associates at (617) 361-2001.

1994 IEEE International Workshop on Intelligent Signal Processing & Communications Systems (ISPACS '94), Oct. 5-7. Yonsei University, Seoul, Korea. Contact Prof. Yeong Ho Ha, Dept. of Electronic Engineering, Kyungpook National University, Taegu 702-701, Korea; (82)-53-950-5535; fax (82)-53-950-5505; e-mail: yhha@ee.kyungpook.ac.kr.

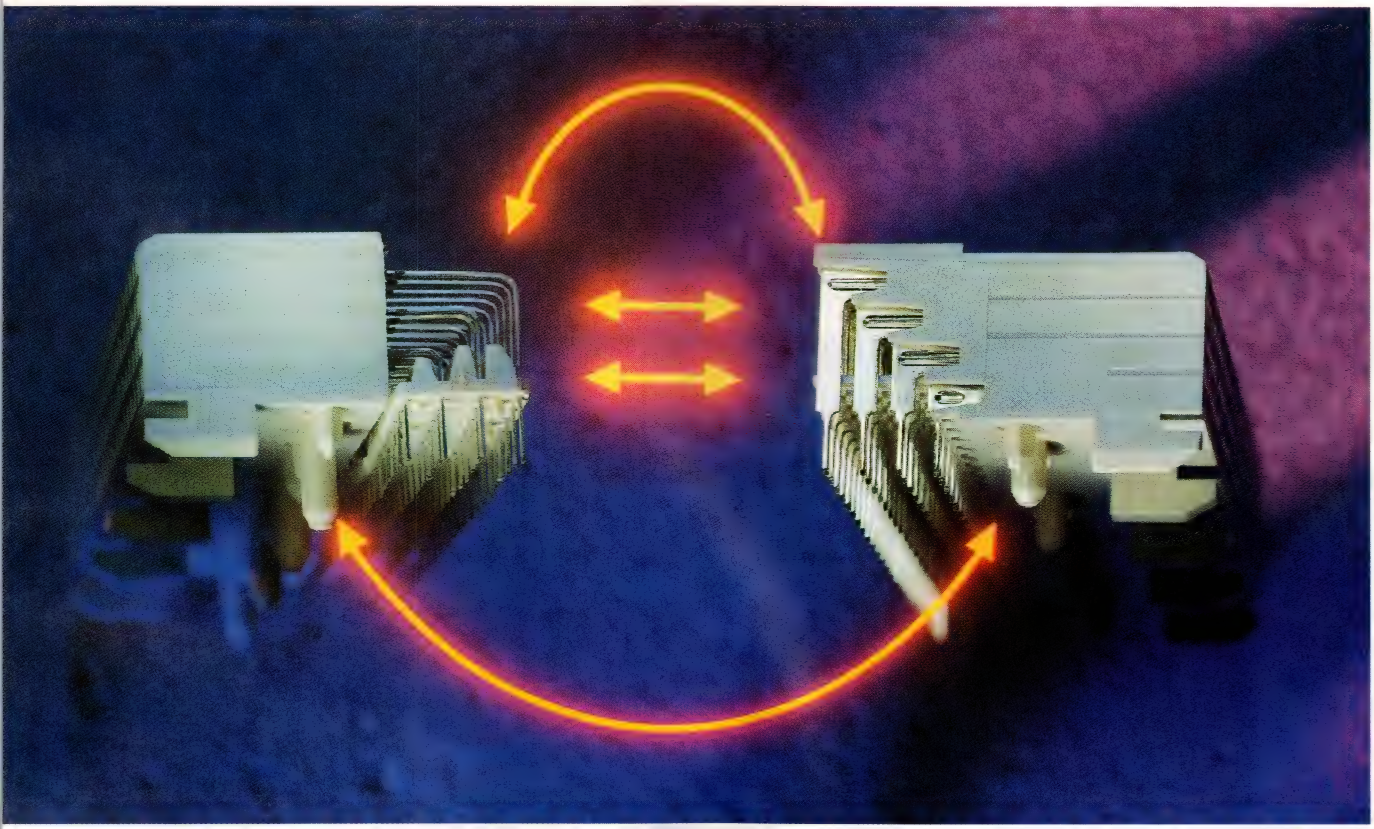
1994 7th International Conference on Parallel & Distributed Computing Systems, Oct. 6-8. Las Vegas, NV. Contact Dr. Kia Makki, Dept. of Computer Science, University of Nevada, 4505 Maryland Pkwy., Las Vegas, NV 89154; (702) 895-4024; fax (702) 895-4075; e-mail: kia@univ.edu.

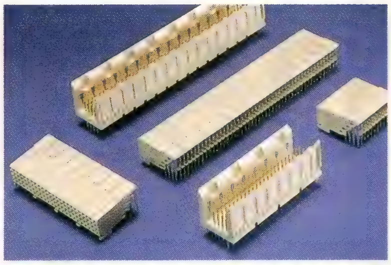
3rd International Exhibition of Computer & Applications for China-Shanghai, Oct. 6-10. Shanghai Centre, Shanghai, China. Contact Ellen Wong, Commerce Tours International Inc., 870 Market, St. Suite 920, San Francisco, CA 94102; (415) 433-3072; fax (415) 433-2820.

1994 12th International Conference on Pattern Recognition, Oct. 9-13. Renaissance Hotel, Jerusalem, Israel. Contact Prof. Shmuel Peleg, Institute of Computer Science, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel; (972)-2-585236; fax (972)-2-585439; e-mail: peleg@cs.huji.ac.il.

1994 International Workshop on Active-Matrix LCDs (AMLCD), Oct. 10-11. Hyatt Regency Hotel, Monterey, CA. Contact Mr. Miltiadis K. Hatalis, 19 Memorial Dr. West, Lehigh University, Bethlehem, PA 18015; (215) 758-3944; fax (215) 758-4561.

Before you go back to the same old future, compare it with ours.





Modular and one-piece "monoblock" versions of AMP Futurebus+ connectors offer significant advantages in handling, production, and use.

If the interchangeability and intermateability of the Futurebus+ standard are important to you, we've got news worth hearing: our Z-Pack 2mm FB line offers just what you want, at a very competitive price – with significant added advantages in production, and in the field.

Compare it with what you may be specifying right now, and the differences are obvious. Their leads are exposed – subject to damage during handling, insertion, rework, and field use. Ours are covered, providing protection and allowing simple, flat-rock tooling for our press-fit versions. Their lead organizers are loose, separate pieces; ours are an integral part of the connector body. With this connector, truer position means easier insertion. Note that their leads are bent to shape. Ours are stamped in shape for structural strength, and use more metal.

Their connectors require heat-staking, or – with press-peg holddowns – high board insertion forces. Ours has a patented "Cold Hold" system, with a metal spring barb embedded in the plastic post. This gives a low force fit with excellent strength and retention.

And we offer one-piece "monoblock" styles to simplify inventory and cut manufacturing effort even more. The bottom line: our version of the future offers you a whole lot more. Just give us a call.

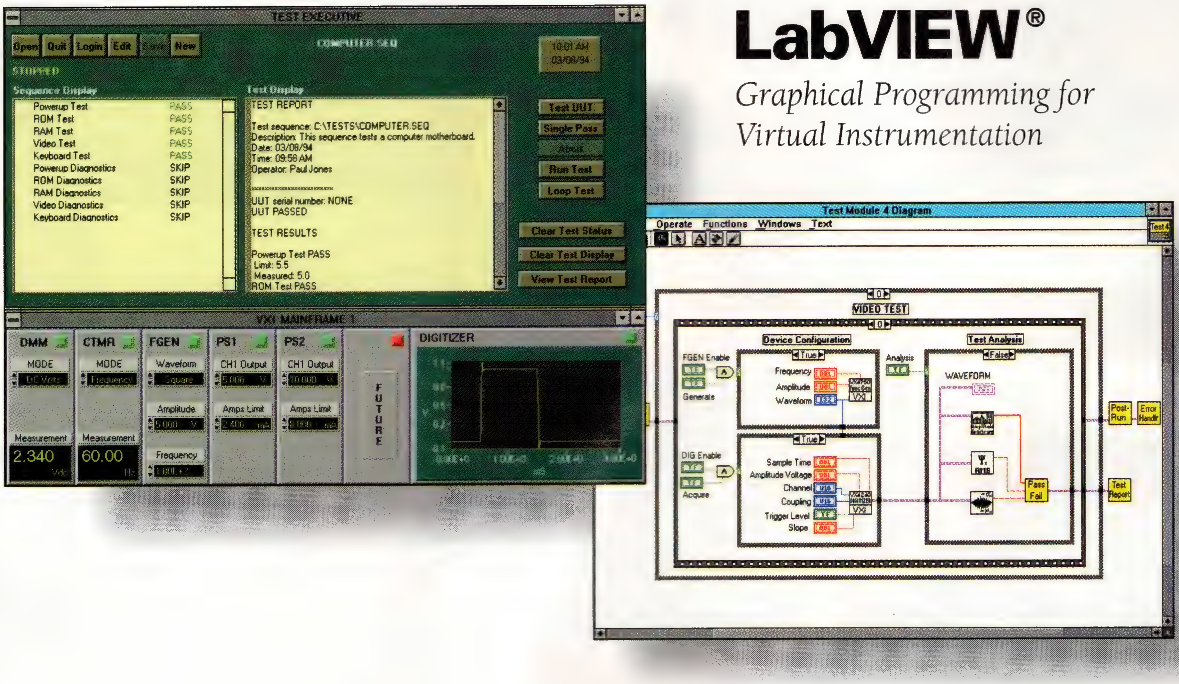
AMP and Z-Pack are trademarks.

Scandinavia: Sweden 46-8-580-833-00 (fax 46-8-580-194-70)
Central Europe: Holland 31-73-20-0911 (fax 31-73-21-2365); Germany 49-6103-7090 (fax 49-6103-709223);
Great Britain 44-81-954-2356 (fax 44-81-954-6234)
Southern Europe: France 33-1-34-20-8888 (fax 33-1-34-20-8600); Italy 39-11-401-21111 (fax 39-11-403-1116);
Spain 34-3-200-8466 (fax 34-3-201-7879)

AMP

READER SERVICE 194

What's Revolutionizing the Test Industry



Powerup Test	PASS
ROM Test	PASS
RAM Test	PASS
Video Test	PASS
Keyboard Test	PASS
Powerup Diagnostics	SKIP
ROM Diagnostics	SKIP
RAM Diagnostics	SKIP
Video Diagnostics	SKIP
Keyboard Diagnostics	SKIP

TEST REPORT

Test sequence: C:\TESTS\COMPUTER.SEQ
Description: This sequence tests a computer motherboard.
Date: 03/08/94
Time: 09:58 AM
Operator: Paul Jones

UUT serial number: NONE
UUT PASSED

TEST RESULTS

Powerup Test PASS
Limit: 5.5
Measured: 5.0
ROM Test PASS

DC Volts
Frequency
Square
2.340 Vdc
60.00 Hz

LabVIEW®

Graphical Programming for Virtual Instrumentation

Virtual Instru

A True Breakthrough in Instrumentation

Virtual Instrumentation is revolutionizing the test industry. How? By empowering you to build your test systems better than ever before. Reusing both hardware and software from one system to the next. Easily enhancing existing systems to meet future needs. Using your existing instruments and even leveraging your existing code. Most importantly, doing all this in less time and for less money using industry-standard computers and object-oriented software.

A True Breakthrough in Productivity

Virtual instrumentation is much more than a graphical user interface or a layer of icons in the name of "ease of use" – it's a new philosophy. A philosophy that delivers a true breakthrough in efficiency and productivity. Where software is optimized for you and by you. Where both hardware and software are open, modular, reusable, and interchangeable. Where vendor-defined becomes user-defined through flexible software combined with general-purpose instruments.

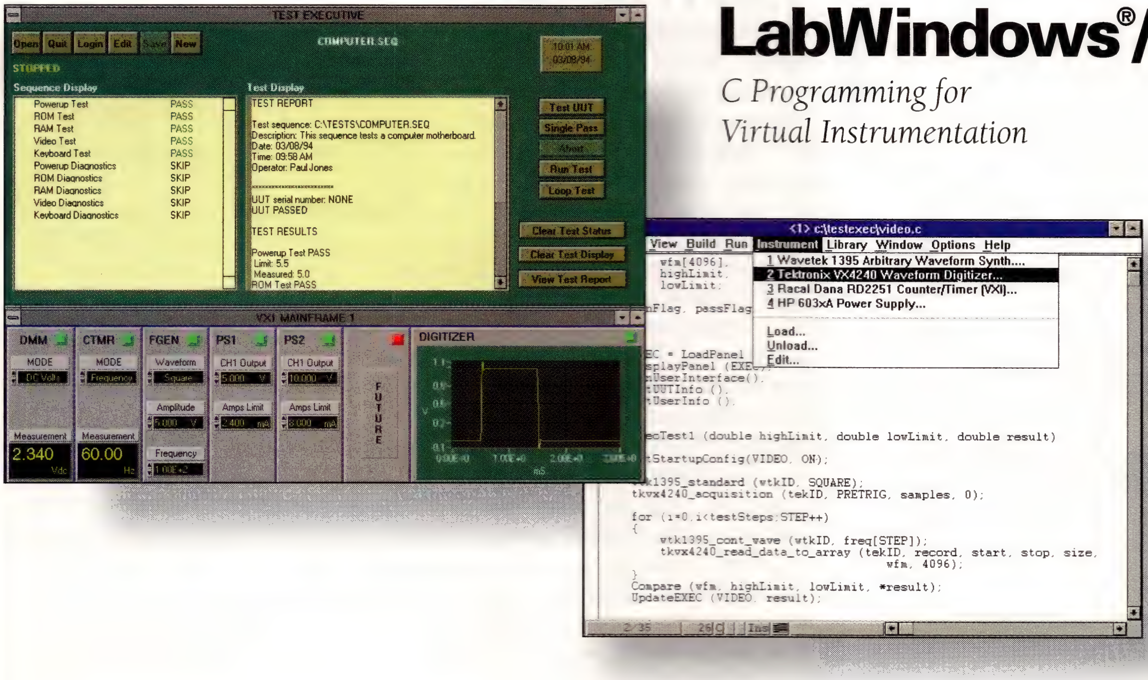
A True Breakthrough in Software

At National Instruments we understand the importance of software for virtual instrumentation. That's why we've pioneered this revolution with the test industry's two leading software products.

Branch Offices: Australia 03 879 9422 • **Austria** 0662 435986 • **Belgium** 02 757 00 20 • **Canada** 519 622 9310 • **Denmark** 45 76 26 00 • **Finland** 90 527 232
France 1 48 14 24 24 • **Germany** 089 741 31 30 • **Italy** 02 48301892 • **Japan** 03 3788 1921 • **Mexico** 95 800 010 0793 • **Netherlands** 03480 33466
Norway 32 848400 • **Singapore** 6359015 • **Spain** 91 640 0085 • **Sweden** 08 730 49 70 • **Switzerland** 056 20 51 51 • **U.K.** 0635 523545

LabWindows®/CVI

C Programming for
Virtual Instrumentation



Powerup Test	PASS
ROM Test	PASS
RAM Test	PASS
Video Test	PASS
Keyboard Test	PASS
Powerup Diagnostics	SKIP
ROM Diagnostics	SKIP
RAM Diagnostics	SKIP
Video Diagnostics	SKIP
Keyboard Diagnostics	SKIP

```
TEST REPORT

Test sequence: C:\TESTS\COMPUTER.SEQ
Description: This sequence tests a computer motherboard.
Date: 03/08/94
Time: 09:58 AM
Operator: Paul Jones

*************************
UUT serial number: NONE
UUT PASSED

TEST RESULTS

Powerup Test PASS
 Limit: 5.5
 Measured: 5.0
ROM Test PASS
```

```
    wfm[4096],
    highLimit,
    lowLimit;

nFlag, passFlag

EC = LoadPanel
splayPanel (EXEC);
nUserInterface();
tUUTInfo ();
tUserInfo ();

eoTest1 (double highLimit, double lowLimit, double result)

tStartupConfig(VIDEO, ON);

wtk1395_standard (wtkID, SQUARE);
tkvx4240_acquisition (tekID, PRETRIG, samples, 0);

for (i=0;i<testSteps;STEP++)
{
    wtk1395_cont_wave (wtkID, freq[STEP]);
    tkvx4240_read_data_to_array (tekID, record, start, stop, size,
                                   wfm, 4096);
}
Compare (wfm, highLimit, lowLimit, *result);
UpdateEXEC (VIDEO, result);
```

mentation.

If you like graphical programming, choose LabVIEW, **the** graphical language that others are judged by. If you like conventional programming, choose LabWindows/CVI, **the** only interactive C environment designed for building virtual instruments.

A True Breakthrough in Functionality

Both LabVIEW and LabWindows/CVI feature extensive GPIB and VXI instrument drivers in source code – for instruments from more than just one vendor – drivers for plug-in DAQ boards, powerful test executives, industry-standard connectivity, and links to your existing code. And with compiled speed and a single, consistent programming paradigm from top to bottom, you don't need to struggle with a hodgepodge of different tools to build your system.

A True Breakthrough in Test

If you think there's a lot at stake here, you're right. Virtual instrumentation redefines the test industry, shifting the balance of power from vendors to you – so you define the future.

Join the Virtual Instrument Revolution and discover why... The Software is the Instrument.

For your FREE LabVIEW or LabWindows/CVI demonstration package call (800) 433-3488 (U.S. and Canada)

NATIONAL INSTRUMENTS®
The Software is the Instrument®

Corporate Headquarters • 6504 Bridge Point Parkway • Austin, TX 78730-5039 USA • Tel: (512) 794-0100 • Fax: (512) 794-8411

© Copyright 1994 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

Circle 121 for more information on Lab View
Circle 179 for more information on Lab Windows/CVI

Serial/Parallel Conversion or Networks

CY233 connects up to 255 computers, peripherals, or remote sites. 5v CMOS 40-pin IC works with RS232/422 drivers. 300 baud to 57.6K baud. Supports a token in Peer or Host ring LAN modes. Numerous other operational modes:

Parallel to Serial
Parallel TTL Data & Strobes
CY233
Serial Out

Wire Saver
Parallel
CY233
Serial
CY233
Parallel

Serial to Parallel
Serial In
CY233
Parallel Out, Strobes & Mode Selection

Host Ring
Serial Ring Network with up to 255 Nodes or stations (2048 I/O Lines)
CY233 CY233 CY233

Party Line
Alternate Topology for 256 8-bit TTL Ports or 2K I/O Lines
CY233 CY233 CY233
8-bit TTL

Host Ring LAN
Master/Server
Token Ring Option
2 CY233s per Node
Serial

Only $45 each ($16/1K). Prototyping or LAN kits also avail. Call for free info or to order $10 manual. Credit card OK.

Cybernetic Micro Systems, Inc
PO Box 3000 • San Gregorio CA 94074
Tel: 415-726-3000 • Fax: 415-726-3003

READER SERVICE 183

SETTING IT STRAIGHT

I've been writing about the electronic industry for about eight years now, and the cliche I seem to run across most often is: "The strong suit of U.S. engineers is their ability to innovate." In what can best be called an excessively broad characterization, American engineers were labeled as innovative and creative but basically uninterested in mundane subjects like manufacturing, testing and quality assurance.

During the latter half of the 1980s, this characterization was offered as one reason for the decline in U.S. market share in semiconductors. Because U.S. engineers were supposedly more interested in "glamorous" pursuits such as design, the nation's manufacturing base had gone to pot. This is a classic case of finding a scapegoat. Never mind that management and Wall Street were so focused on the bottom line that necessary investments weren't being made. The imbalance-of-trade problem was blamed at least partially on the supposedly shared personality of engineers.

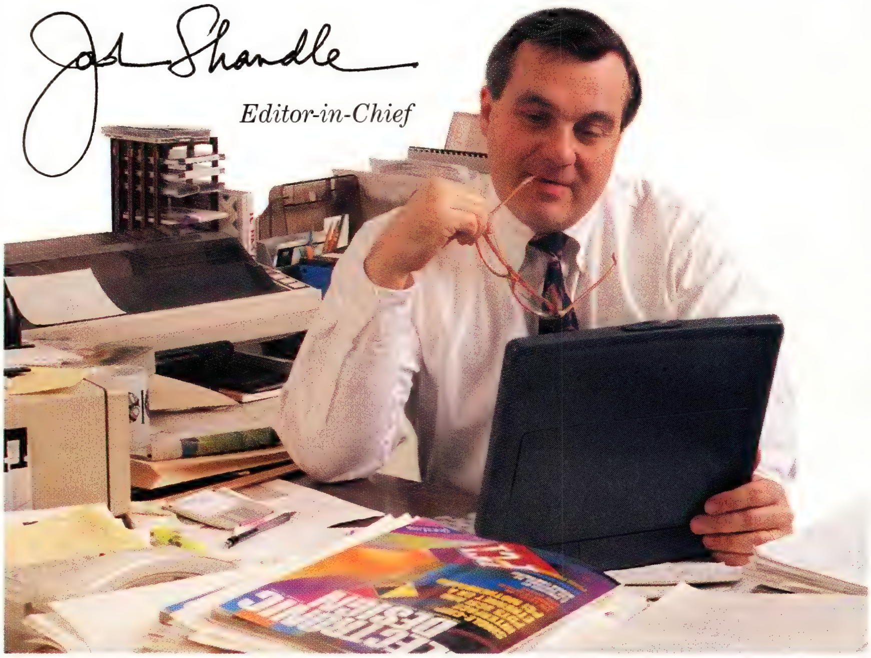
The situation has swung around since the doldrums of the late 1980s. In my view, one of the major reasons for the turnabout are the quality programs put in place by most if not all companies. These quality programs required, by the way, significant investment—quality doesn't come cheap. Let me just guess that the years prior to the corporate awakening were tough ones on the manufacturing floor. Engineers knew what needed to be done but no one was listening. Quality programs and other investments in people weren't the ways that upper management preferred to spend money prior to finding themselves captains of sinking ships.

Now that the U.S. computer and semiconductor industries seem to be on the rebound, it's time to check out some of the old assumptions. I doubt very much that the legions of U.S. engineers across the nation had sudden and complete personality changes. It seems unlikely that the supposed prima donnas of the last decade have gone through a closet Cultural Revolution and been reprogrammed into manufacturing fanatics. The most probable scenario is that the salary scale for the manufacturing engineer has come more in line with the salary scale of the design engineer.

I think we should learn a lesson from the past several years and stop trying to fix blame on a supposed personality type of a particular group, especially when the group is so demographically diverse as the engineering community.

Josh Shandle

Editor-in-Chief



GaAs

SWITCHES

DC-2GHz Immediate Delivery from $2.30 (1000 qty.)

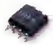
Finally! A line of SPDT absorptive, reflective and transfer switches that appeals to your technical side, and business side as well! It's Mini-Circuits GaAs switches...providing outstanding performance features such as very high isolation (up to 60dB), superfast 3nsec switching speed and excellent compatibility with surface mount soldering techniques. Additionally, the entire series is built extremely tough and is immediately available from stock with a 1 week shipment guarantee. At only $2.95 (qty.10), this top-of-the-line value is priced with your bottom line in mind! To order, call or Fax Mini-Circuits with your requirements today.

Mini-Circuits...we're redefining what VALUE is all about!

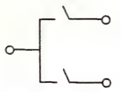
Model No.	Freq. (GHz)	Insertion Loss ① dB (max.)	1dB Comp. ① dBm (typ.)	In-Out Iso. ① dB (typ.)	Price $ea. (qty.10)
MSW-2-20 (Reflective)	DC-2.0	1.0	+24	34	2.95
MSWA-2-20 (Absorptive)	DC-2.0	1.3	+27	40	3.45
MSWT-4-20 (Transfer)	DC-2.0	1.8 TX ② 2.0 RX ③	+28 TX ② +27 RX ③	30	3.95

① Midband, 500-1000MHz ② Transmit ③ Receive

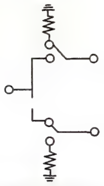
All Units: SOIC 8pin Package



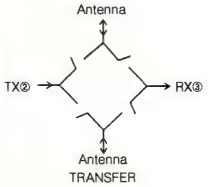
Actual Size



SPDT REFLECTIVE



SPDT ABSORPTIVE



TRANSFER

Mini-Circuits®

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

*CUSTOM PRODUCT NEEDS...**Let Our Experience Work For You.***

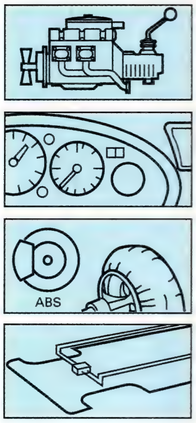
F 174 Rev Orig

READER SERVICE 115

SIEMENS

Driving for System Solutions

Todays family car contains an ever increasing number of electronic components. With them, manufacturers have introduced a wide range of features for greater safety, economy and convenience. Siemens semiconductors supply the drive for advanced automotive solutions.



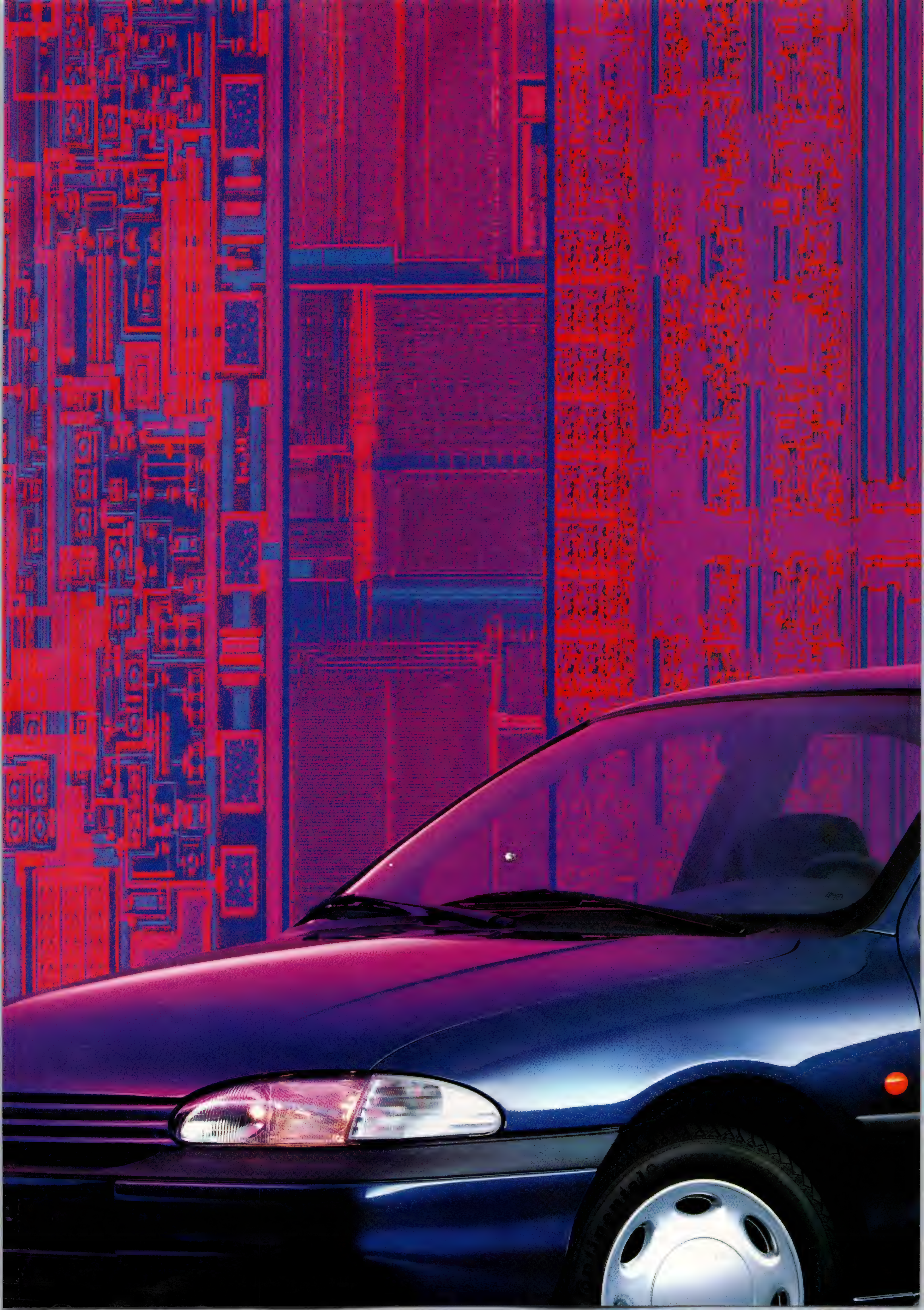
Our approach is systematic – whether in sensors like our effect Hall ICs used in ABS and to detect crank and cam speed – or in high-speed multi-tasking controllers. We go further than meeting simple performance criteria by offering ASICs and custom solutions. Such flexibility means we can cater for any design and provide you with an integrated solution.

The same applies to our Smart Power integrated circuits, whose technology really gives you the edge. These, like all our components, are carefully designed in packages that offer industrial users distinct processing benefits.

More information by fax
49-911-3 00 12 38, quoting HL 9115

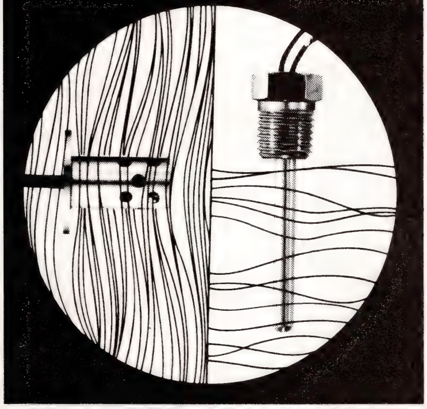
Global PartnerChip
for Systems on Silicon.
Siemens

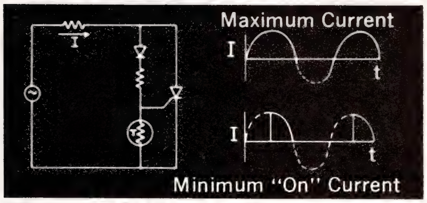
READER SERVICE 130



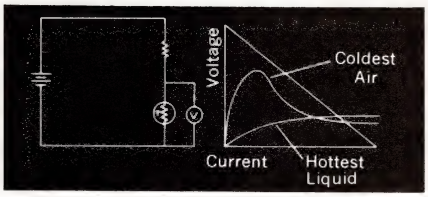
LEADERSHIP IN
THERMISTOR
TECHNOLOGY

Keystone
THERMISTOR
TASK MINDERS





TEMPERATURE CONTROL
As the resistance of the thermistor decreases, a larger voltage is required to fire the SCR. In this circuit, conduction angles from 90° to 180° can be achieved. Thus, the minimum "on" current will be 50% of the maximum "on" current.



LIQUID LEVEL DETECTION
Taking advantage of the difference in dissipation constant between a liquid and a gas enables thermistors to serve as liquid level sensors over a wide range of temperatures.

Keystone
CARBON COMPANY

Thermistor Division • St. Marys, PA 15857
814-781-1591 • FAX 814-781-7648

Keystone Thermistors are distributed by

Allied Electronics	1-800-433-5700
Dexter Corporation	1-800-345-4082
Digi-Key Corporation	1-800-344-4539
Newark Electronics	1-800-367-3573
Summit Distributors	1-800-678-6648

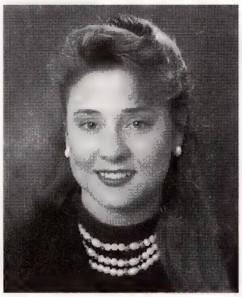
READER SERVICE 97

SENSORS SEEK BETTER FAB TECHNOLOGY

An interesting thing happened to me not long ago. My husband Tom and I went shopping for a new vehicle, a fully loaded Toyota 4-Runner. While he stood mesmerized by its chrome finish, towing receiver hitch, custom running boards, and buffed mud-and-snow tires, I sat in the driver's seat thinking about the car's sensors. As an avid consumer and industry watcher, I was quite interested.

It occurred to me that one of the largest markets in the sensor industry today is pressure sensors. Most find use in the automotive industry in everything from on-board fuel-, oil-, and tire-pressure monitors, to ABS brakes, to air-induction systems. Someday we'll even see pressure sensors in power-train controllers, flex-fuel modules, and power-seat positioners.

As a consumer, I realize that the cheaper the sensor is to manufacture, the less I pay. And as long as their reliability is good, I probably won't have to worry about them during the car's life. As an industry observer I'm keenly aware of the ever-increasing complexity of pressure-sensor designs, and the demand for smaller, higher-performance, low-cost devices. Today, a great deal of research is aimed at improving the micromachining fabrication processes, whether surface or bulk, to meet industry demands.


CHERYL J. AJLUNI
WEST COAST EDITOR

Bulk micromachining has been commercialized and is used in virtually all silicon-based sensors. Surface micromachining, on the other hand, is mostly confined to academia, with the exception of Analog Device's accelerometer, which now is being designed into automobiles. Both technologies involve trade-offs, and the best uses of each will be resolved by the marketplace. Analog Devices, with its accelerometer, may be on the right track by being the first to successfully commercialize what was once strictly limited to the academic realm.

Many labs, including the Microsystems Technology Laboratory, MIT, and the Honeywell Technology Center, are investigating microstructures. One of the major motivations behind the work is the compatibility surface microstructures have with complex IC processes. In bulk micromachining, geometries are produced that interfere with IC processing and are often incompatible with fabricating CMOS devices. Hence, processing steps are severely restricted to those in which the circuitry will survive. This isn't the case for surface microstructures.

There are certain advantages to using bulk micromachining, though. Single-crystal silicon from the bulk of a wafer is traditionally stronger, easily reproducible, and more stable than the deposited polysilicon materials found in surface microstructures. Also, polysilicon materials are limited to about 2 μ in thickness, compared with 400 μ for bulk devices. This allows for significantly higher response and sensitivity. Lastly, surface devices must be made smaller than bulk devices due to their thin mechanical layers, which in turn will cause them to generate smaller signals than their bulk-formed counterparts.

While surface-microstructure research pushes on, bulk devices continue to provide advanced-technology pressure sensors like the new low-pressure intelligent sensor module from Motorola. Many such devices and developments in micromachining techniques form the core of an upcoming special report in the October 3 issue. The report focuses on the pressure-sensor market and looks at what the industry is doing to accommodate the demands of designers who use pressure-sensing solutions.

By the way, my husband and I now are the proud owners of a new Toyota 4-Runner, equipped with at least four different types of pressure sensors. If you happen to see us, give a wave. We'll be the ones with the bumper sticker that reads: "Pressure sensors on board—making life a little bit easier".

The Most Significant Advance in MIL-STD-1553/1760

National Hybrid has significantly advanced the envelope in multi-chip components for MIL-STD-1553 and MAC AIR data bus systems—solving critical problems of size, performance, power, reliability, complexity and cost.

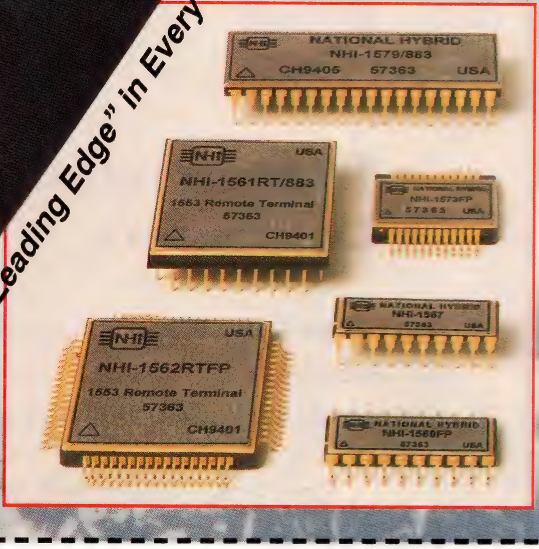
Reduced Size! The NHI-1561RT 69-pin dual redundant remote terminal, with monolithic transceivers—ceramic PGA or quad flat-pack—measures only 1.1" square! The NHI-1567 monolithic dual transceiver, packaged in standard 20-pin cer-dip, is only 1.0" x 0.3"!

Enhanced Performance! The remote terminal appears to the host computer as 4K words of 16-bit-wide memory controlled by standard RAM signals. It can therefore be easily interfaced with all processors and buses. It also has superior noise performance and lower thermal impedance.

READER SERVICE 245

21st Century Multi-Chip Components...

... "Leading Edge" in Every Detail.



roved Reliability!
)-fired ceramic packaging
ninates glass-to-metal-
al problems. Radia-
n tolerance is superior,
d the dual transceivers' output
ver can withstand short circuit
lt indefinitely!

luced Power! The Monolithic
al Transceivers dissipate only 0.95 Watts
100% duty cycle!

npler! All devices operate on a
gle +5 Volt ±10% power supply, and are
y compliant to MIL-STD-1553/1760
er the full -55 to +125°C temp
ge. Transmitter outputs for
ch channel are connected
ernally to receiver inputs,
ulting in only two bus
nnections per channel
he coupling
nsformer.

ver Cost! You can now
mply with MIL-STD-1553
MAC AIR without cost penalty.
ey're plug-compatible and priced identically!
are qualified to DESC standardized military drawings.

To obtain the devices you need for prototyping, please mail or fax the coupon. One of our applications engineers will be right back to you. Better yet, phone our Marketing Department directly.

rthrop Grumman B-2—Photo Courtesy US Air Force, HQ Air Combat Command

NHi

National Hybrid, Inc.
2200 Smithtown Ave.
Ronkonkoma, NY 11779

Phone 516-981-2400
Fax 516-981-8888

☐ **Please send the User's Manual for the new-generation multi-chip components, as checked below.**

☐ **Also, please have an Applications Engineer call. I will be needing devices for prototyping. Thank you.**

- ☐ Monolithic Dual Transceivers
- ☐ Dual Redundant Remote Terminal, Monolithic Transceivers
- ☐ Enhanced Terminals—Bus Controller, Remote Terminal, Bus Monitor, SRAM, & Transceivers
- ☐ Advanced Terminals—Dual Redundant RISC Processor-based Bus Controller, Remote Terminal, Bus Monitor, & Internal RAM
- ☐ Mil-Std 1553
- ☐ Mac Air
- ☐ Plug-In
- ☐ Surface Mount

Name ____________________ Title ____________________

Company ____________________ Phone ____________________

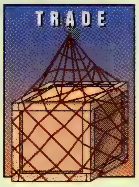
Address ____________________ Fax ____________________

City, State, Zip ____________________

COMPLIMENTARY ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:



- **Telecommunications**
- **Computers**
- **Semiconductors**
- **International trade**

☐ **YES!** Send me my **FREE** issue of ***ELECTRONICS*** and enter my 1-year subscription, 23 issues—**for 10% off the regular subscription rate!** If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates (U.S. funds drawn from a U.S. bank):

☐ U.S. ~~$98~~ $88 ☐ Canada ~~$120~~ $108 (plus GST) ☐ Other Countries ~~$190~~ $171

Please bill my credit card: ☐ Visa ☐ MasterCard ☐ AMX ☐ Discover

Card No. ______________________ Exp. Date ______________________

Signature ______________________ Date ______________________

Name ______________________ Title ______________________

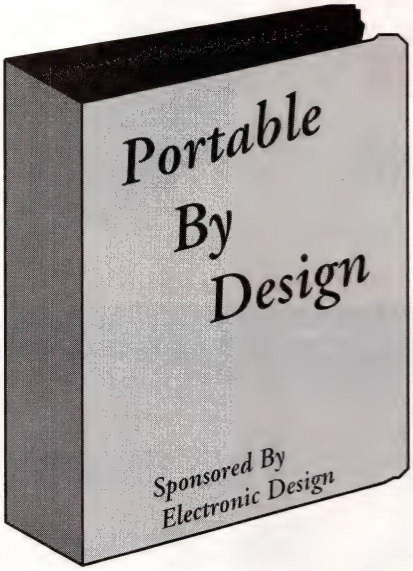
Company ______________________

Mailing Address ______________________

Order by FAX: 216/696-6413 or call 216/696-7000, x 4137

1EDh4c

Proceedings of Portable By Design
Sponsored By Electronic Design Magazine



Price $150.00 per copy (add $12.00 shipping & handling per copy)

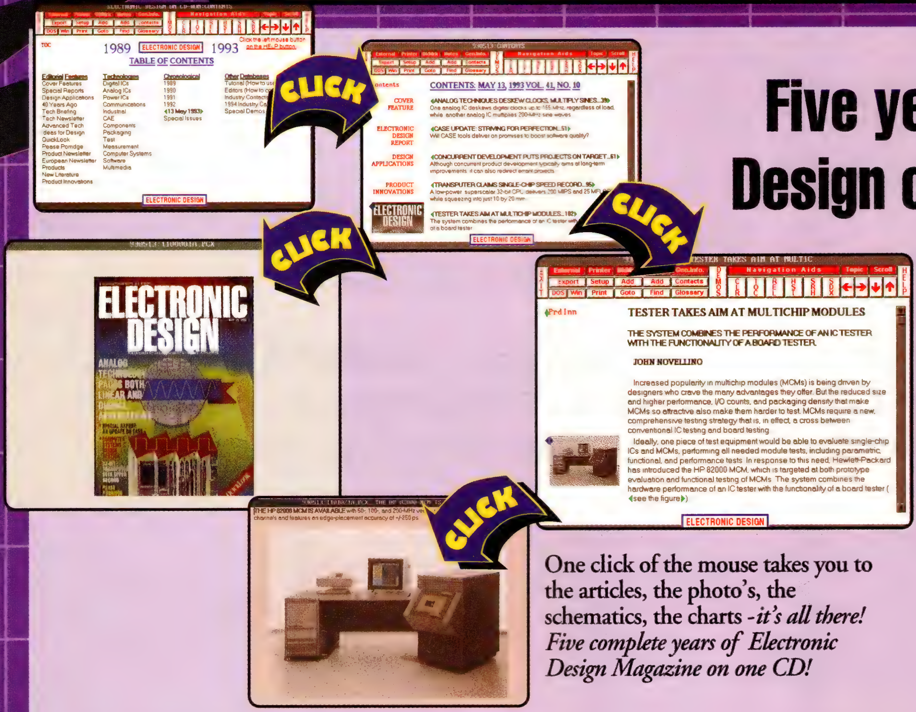
A conference for OEM Designers of portable, nomadic, mobile, transportable and hand-held products. The product areas covered in these proceedings include almost 800 pages of information on:

* Power Circuits
* Connectivity
* Input Devices
* Managing Mechanical/Electrical Design Teams
* Expandability/Configurability
* Engineering The Whole System
* High End Microprocessors
* Low-Power Microncontrollers
* Power Management
* Application Development & Operating Systems
* Batteries
* Displays

For additional or ordering information, please call (201) 393-6075

ELECTRONIC DESIGN: 1989–1993
FIVE YEARS
OF
ELECTRONIC
DESIGN
ON CD-ROM
FOR ENGINEERS AND ENGINEERING MANAGERS—
1993
1992
199
1990
198
DEMOS
CLIC

COMPLETE 30-DAY MONEYBACK GUARANTEE! If you're not satisfied after 30 days, send it back and owe nothing!



TOC

1989 ELECTRONIC DESIGN 1993

Click the left mouse button on the HELP button.

TABLE OF CONTENTS

Editorial Features	Technologies	Chronological	Other Databases
Cover Features	Digital ICs	1989	Tutorial (How to use
Special Reports	Analog ICs	1990	Editors (How to co
Design Applications	Power ICs	1991	Industry Contacts
40 Years Ago	Communications	1992	1994 Industry Ca
Tech Briefing	Industrial	13 May 1993	Special Demos
Tech Newsletter	CAE	Special Issues	
Advanced Tech	Components		
Ideas for Design	Packaging		
QuickLook	Test		
Pease Porridge	Measurement		
Product Newsletter	Computer Systems		
European Newsletter	Software		
Products	Multimedia		
New Literature			
Product Innovations			

ontents

CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE — ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...39 One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves.

ELECTRONIC DESIGN REPORT — CASE UPDATE: STRIVING FOR PERFECTION...51 Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS — CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...61 Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects.

PRODUCT INNOVATIONS — TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95 A low-power superscalar 32-bit CPU delivers 200 MIPS and 25 MFL while squeezing into just 10 by 20 mm.

TESTER TAKES AIM AT MULTICHIP MODULES...102 The system combines the performance of an IC tester with of a board tester.

Prd Inn

TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

Ideally, one piece of test equipment would be able to evaluate single-chip ICs and MCMs, performing all needed module tests, including parametric, functional, and performance tests. In response to this need, Hewlett-Packard has introduced the HP 82000 MCM, which is targeted at both prototype evaluation and functional testing of MCMs. The system combines the hardware performance of an IC tester with the functionality of a board tester (see the figure)

THE HP 82000 MCM IS AVAILABLE with 50-, 100-, and 250-MHz ver channels and features an edge-placement accuracy of ±250 ps.

One click of the mouse takes you to the articles, the photo's, the schematics, the charts *-it's all there! Five complete years of Electronic Design Magazine on one CD!*

Five years of Electronic Design complete on one CD

- *All the articles*
- *All the photographs*
- *All the schematics*
- *All the drawings*
- *All the editorials*
- *All the letters*

THIS CD-ROM, produced by the Editors of Electronic Design Magazine, contains five complete volumes - that's 124 past issues of Electronic Design Magazine. Presented in 16-color VGA, it's packed with more than 4,000 photos and graphics. All the articles, features, product reviews, product updates *(even product demos!)*, editorials, letters are included - everything electronics industry professionals expect from Electronic Design.

All of the information in this CD is made instantly accessible through a powerful Hypertext application called *Hyperwriter*™.

Hyperwriter™ makes the information on this disk instantly accessible through hypertext links. Links made directly through each topic (article) to pictures, illustrations, schematics, full glossaries, product demos, and contact names, plus past and subsequent related topics.

Specific topics are quickly located using the powerful search features provided. Using a key-word or key word strings, you get a list of all related topics-*instantly.*

Instant comprehensive information. That's what this disk is al about.

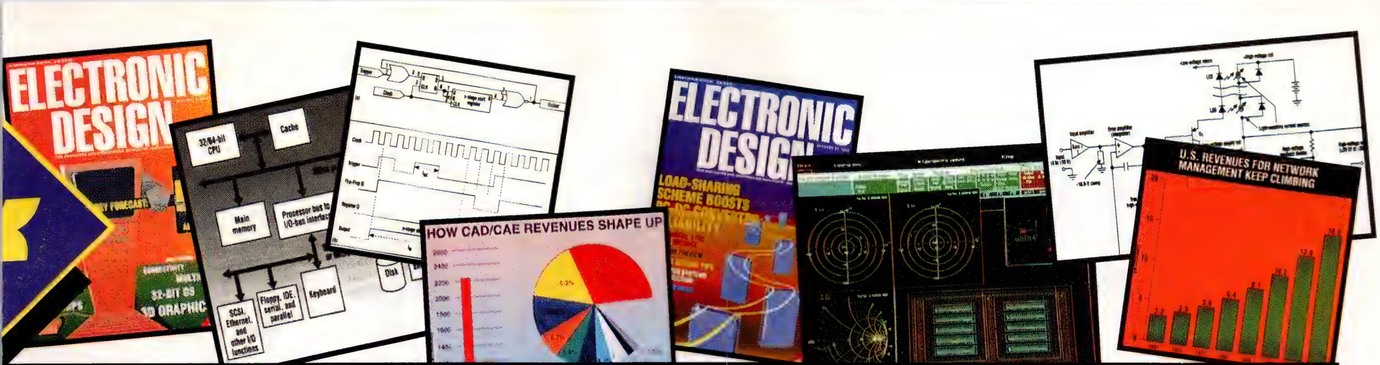
International phone orders call: *201-393-6060* • ***Inside USA:*** *800-829-9028-9am-5pm est.* • ***To order by fax:*** *201-393-0204*
To order by mail: *Send your order to: Electronic Design Magazine, 611 Route 46 West, Hasbrouck Heights, NJ 07604*

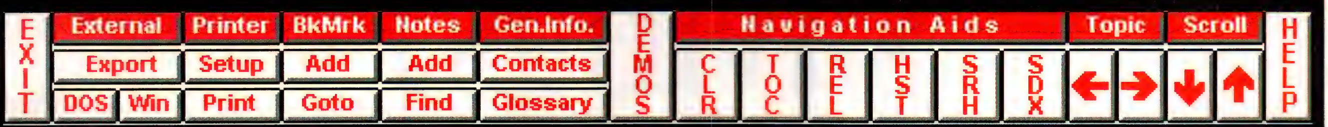
5 Years of Electronic Design Magazine on CD-ROM (1989-93) $\$295^{00}$

1 Year of Electronic Design Magazine on CD-ROM (1993) $\$95^{00*}$

Network 1 & 5 year versions also available - call for details

** Upgrade to the 5 year version within 90 days and pay only $200*

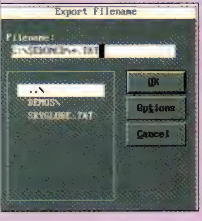

ELECTRONIC DESIGN
ELECTRONIC DESIGN
HOW CAD/CAE REVENUES SHAPE UP
U.S. REVENUES FOR NETWORK MANAGEMENT KEEP CLIMBING



Learn the backbone of the Electronic Design Magazine CD-ROM interface - the BUTTONBAR.

Powerful, hypertext-based commands let you quickly and efficiently find, re-find, link, make notations, leave bookmarks, export, print, search, get product demos, and even return to your operating system!

External - Life beyond this disk



The **Export** button will export any or all of an article based on your selection.

DOS & Win

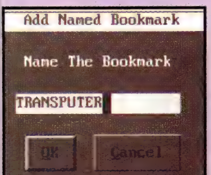
DOS brings you to the DOS prompt screen and **Win** takes you into Windows™ without quitting the application. These buttons make it easy for you to return to Electronic Design Magazine, where you left off, without re-launching.

Printer Commands

Setup & Print - This feature allows you to print articles, editorials, glossaries, illustrations, and even photos *(if your printer is capable)* directly from this CD. Great source for reference.

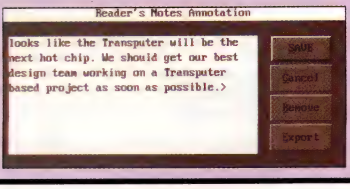
Bookmarks and Notes

BkMrk - Bookmarks flag topics for future reference, just like using a bookmark in a real magazine. Mark a spot, and the bookmark is stored even if you quit.



GOTO brings you back to your bookmarks. Deleting them is just as simple.

Notes - Add and find your own notations. Notes stay until you delete them, even after you quit.



```
looks like the Transputer will be the
next hot chip. We should get our best
design team working on a Transputer
based project as soon as possible.>
```

Gen. Info - Complete reference

Contacts - Company names, addresses, contact names, phone numbers- all of the information you need to follow up.

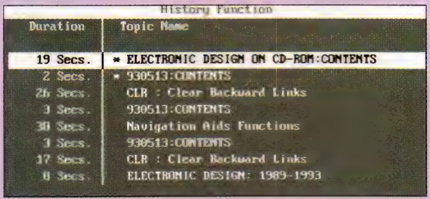
Glossary - Full article glossaries, provided by the Editors of Electronic Design magazine. The CD also comes with **WORD LINK**, which allows you to click on any word within the article and if it's in the glossary, the definition pops up. When you're done, a simple click and it's gone.

Navigation Aids - Magellan you're not, and you don't need to be!

All the aids you'll need to motor your way through this CD in no time flat.

CLR - *Clear Back Links* - Because every article you move to loads into RAM, this function allows you to clear articles you've finished. This frees up RAM for you to continue.

TOC - *Table of Contents* - Takes you directly to the Volume Table of Contents (the whole year) with special links provided to Issue T.O.C.



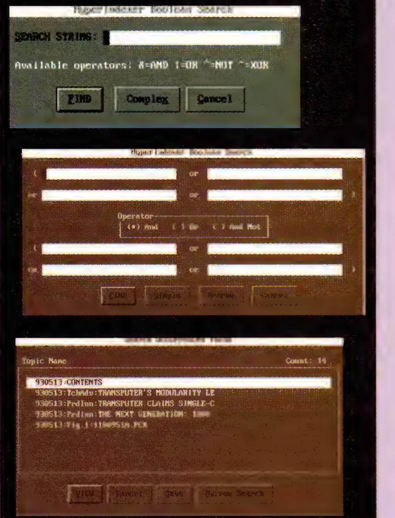
```
                    History Function
 Duration     Topic Name

  19 Secs.   * ELECTRONIC DESIGN ON CD-ROM:CONTENTS
   2 Secs.   * 930513:CONTENTS
  26 Secs.     CLR : Clear Backward Links
   3 Secs.     930513:CONTENTS
  38 Secs.     Navigation Aids Functions
   3 Secs.     930513:CONTENTS
  17 Secs.     CLR : Clear Backward Links
   0 Secs.     ELECTRONIC DESIGN: 1989-1993
```

REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

HST - *Show-Related History* - Shows each topic visited during your current session and how long you were there, and then lets you return to previous topics.

SEARCH dialog boxes

Simple search (top), Complex Search (center), and Search occurances found (bottom).



```
SEARCH STRING:
Available operators: &=AND |=OR ^=NOT ~=XOR
```

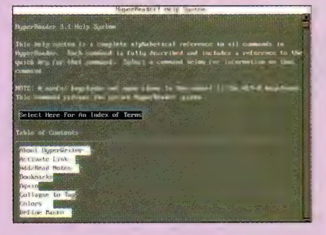
```
Topic Name                                   Count: 14
 930513:CONTENTS
 930513:TchAdv:TRANSPUTER'S MODULARITY LE
 930513:PrdInn:TRANSPUTER CLAIMS SINGLE-C
```

SRH - *Search* - Conduct simple, complex or proximity indexed searches.

SDX - *Subject Index* - A hierarchical list of key subject areas compiled by the Editors of Electronic Design. The index also allows direct access to related topics.

HELP - Instant on-line help for all

Written in plain, easy to understand terms providing information for novice and pro alike. Available in any user screen.

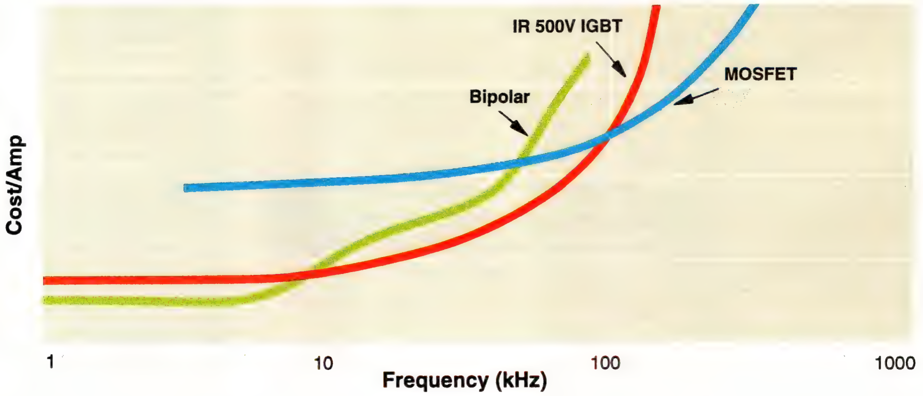


MINIMUM SYSTEM REQUIREMENTS

- ☞ 80386 PC or better
- ☞ VGA video card adaptor w/640 x 480 pixel resolution 16 colors.
- ☞ 1 meg ram
- ☞ MS-DOS Version 3.1 or later

Power Supply savings.

Or how to get the lowest cost-per-amp fast, simple and easy.

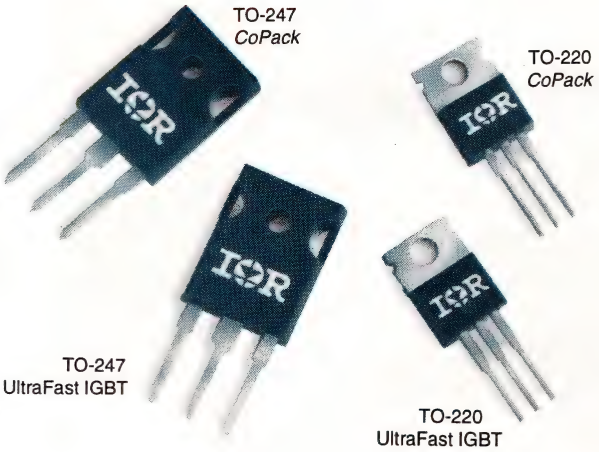


Just plug in IR's UltraFast 500V IGBT. And you instantly improve the efficiency and cost-per-amp of your single-ended off-line switch-mode power supplies. Without redesigning.

Our IGBTs also come paired with IR super-soft recovery diodes in *CoPacks* for half-bridge supplies. All give you the lowest conduction losses ever. And fast switching speeds.

Available from the most cost-effective IGBT line today. Value priced to save you money. In stock to save you delivery time. Send for our IGBT data pack. Or call. 310-322-3331, ext 2529.

You'll easily save more for your converters.



Available now at key IR distributors.

IOR International Rectifier

WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245, USA 310-322-3331, FAX 310-322-3332, TELEX 66-4464. EUROPEAN HEADQUARTERS: HURST GREEN, OXTED, SURREY RH8 9BB, ENGLAND, (0883) 713215, FAX (0883)714234

READER SERVICE 95

TECHNOLOGY NEWSLETTER

NIST RESEARCH YIELDS SUPER-BRIGHT GREEN LEDS

An extremely bright light-emitting diode (LED) with peak wavelengths in the pure-green region of the spectrum has been developed. The project teamed scientists at Eagle-Picher Laboratories, Miami, Okla., and the Physics Dept. of North Carolina State University (NCSU), in Raleigh. Eagle-Picher's technology for producing high-quality crystals of pure zinc-selenide was combined with NCSU's novel fabrication techniques to create LEDs estimated to be more than 50-times brighter than commercial green LEDs. Moreover, the LED, which is brightest at around 510 nm, is significantly more "green" than commercial types (at about 555 nm). These have a pronounced yellowish cast to their light output.

The work was supported by the National Institute of Standards and Technology's (NIST) Advanced Technology Program, Gaithersburg, Md., which is aimed at developing improved technologies for producing blue and green light microsources. Blue and green sources are among the most difficult colors to achieve at high brightness, and such LEDs are key to full-color displays and optical data systems. Next on the project's agenda is addressing the problem of device degradation. With useful lifetimes of several hundred to 1000 hours, the new LEDs still degrade too quickly for commercial use. For more information, contact Eagle-Picher's William Harsch at (918) 542-1801. *DM*

SPEC INTEGRATES DSP INTO WINDOWS

Aimed at 32-bit Windows platforms, such as the forth-coming Windows 4.0, Microsoft has released a DSP software architecture and Resource Manager Interface (RMI) specification. The RMI offers a mechanism for managing signal-processing resources, such as those found in digital-signal processors. It's a three-layered architecture that provides device-independent resource management while simultaneously preserving DSP-specific capabilities.

The top-level interface is used by Windows device drivers to interconnect tasks and resources to perform functions on DSP-based platforms. The middle layer organizes the tasks and resources in a multitasking environment, including concurrency issues and resource conflicts. The bottom layer implements the physical connection to the DSP platform.

The specification is being endorsed by a host of major computer-component suppliers, including AT&T Microelectronics, Creative Technology, IBM, Intel, and Spectron Microsystems. The Resource Manager supplies a common interface for DSP architectures, enabling driver and application developers to bridge their development investment from one product generation to the next. A copy of the specification can be obtained by sending electronic mail to MSDSP@Microsoft.com, or by accessing Compuserve in the Windows Extensions Forum (type Go Winext), library 15, DSPRMI. *RN*

DESIGN PLATFORM TARGETS MULTIMEDIA

A reference design platform has been released that combines key communications and multimedia sound functions into one low-cost ISA-bus hardware platform. The reference design is built around Motorola's 56002 digital-signal processor. Using the platform, system manufacturers will be able to easily incorporate telephony, voice, and audio into their systems. Interfaces are included for a microphone, speakers, a CD-ROM drive, and a game port. The design was codeveloped by Motorola, Austin, Texas, and Compaq Computer, Houston, Texas. It also maintains compatibility with Microsoft's recently released RMI specification for DSP integration.

Because the design is driven by a programmable DSP chip, it can be upgraded easily through software as new applications are written. The reference design specification, called PC Media Hardware Reference Design Version 4.0 (application note #APR19/D), can be obtained free of charge by calling Motorola's Literature Distribution Center at (800) 441-2447. *RN*

TRANSPORT SPEC HELPS MULTIMEDIA DEVELOPERS

By specifying a platform-independent transport, software developers will be able to write multimedia applications to this interface and be assured that their application will operate seemlessly on most standard transport services. Such services include ISDN, LANs, modems, and ATM networks. Previously, developers would have to do some rewriting on the applications for each service.

The transport specification is being handled by a working group within the Multimedia

POWER SPLITTERS/ COMBINERS

the world's largest selection
2KHz to 10GHz from $\$2^{95}$

With over 300 standard models, from 2-way to 48-way, 0°, 90° and 180°, 50- and 75-ohms, covering 2KHz to 10GHz, Mini-Circuits offers the world's largest selection of off-the-shelf power splitter/combiners. And, with rapid turnaround time, we'll also supply "special" needs, such as wider bandwidth, higher isolation, lower insertion loss and phase matched ports.

Available for use in military and commercial requirements, models include plug-in, flat-pack, surface-mount, connectorized standard and custom designs. New ultra-miniature surface mount units provide excellent solutions in cellular communications, GPS receivers, Satcom receivers, wireless communications, and cable systems.

All units come with a one-year guarantee and unprecedented "skinny" sigma unit-to-unit and production run-to-production run repeatability. All catalog models guaranteed to ship in one week. Mini-Circuits... dedicated to exceed our customers' expectations.

Mini-Circuits®

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBO

F134 Rev D

CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

MCL COM ZFSC-24-1
MCL COM ZFSC-10-1-3
MCL COM ZFSC-12-1-3 A78694-11100
MCL ZA3PD-1
Mini-Circuits 15542 SPLITTER ZMSC-3-1
MCL ZB8PD-4
MCL ZBSC-413
Mini-Circuits 15542 ZFRSC-2050B
Mini-Circuits 15542 SPLITTER ZFSC-4-1W
Mini-Circuits 15542 SPLITTER ZFSC-3-1
RF/IF Designer's Handbook
Mini-Circuits

READER SERVICE 112

F134 Rev D

Communications Forum (MMCF), Austin, Texas. The objectives of the working group include the preparation of a document that describes the transport-services interfaces as they relate to the MMCF reference architectural model. For more information, contact Christine Perey, the MMCF media-relations coordinator, at (916) 621-0468, or Mark Abel, working-group chair, at (503) 696-8483. *RN*

AD-HOC GROUP ADDRESSES 3D-PACKAGING STANDARDS

The pressure on designers to transcend the classic "planar" approach to electronic packaging has spawned various approaches to what has been termed 3D packaging. An ad-hoc working group has taken on the task of forming standards for exotic packaging technologies, which range from stacked die and wafers to stacked mother/daughter boards. The group, which sprang out of informal meetings at the Spring Conference on Solid State Memory Technologies, hopes to develop practical standards for 3D packaging that would be acceptable to a wide range of product developers and suppliers of materials, process equipment, and ICs. Some of the issues that the group plans to address include die sizes, known-good die (KGD), trace density, heat-transfer analysis and methodologies, radiation tolerance, topology, known-good stacks (KGS), bonding processes, software tools for place-and-route, testability, redundancy, error management, signal integrity, and repairability. Present members include representatives of Controlex Corp., Datatape Inc., General Electric Corp., Harris Corp., Honeywell, Loral Federal Systems, NASA/Jet Propulsion Labs, TRW Components International, Tanner Research, TechSearch International, and Texas Instruments. For more information, contact Bruce Kaufman of Controlex at (818) 780-8877. *DM*

PROCESS IMPROVES SI-ON-QUARTZ SUBSTRATES

A proprietary SIMOX (Separation by IMplanted OXygen) process technology has been used to create a thin, monocrystalline film of silicon-on-quartz wafers with electrical characteristics that are superior to those of polysilicon films. The process, developed by SOITEC, Grenoble, France, makes wafers for small, high-resolution circuits for which polysilicon-on-quartz is currently used. These include TFT LCDs, charge-coupled device detectors, virtual-reality devices, and HDTV projection systems. Electrical behavior has been shown to be five- to ten-times better on a pure monocrystal than on annealed polycrystal. The monocrystalline film is formed on a quartz wafer and has a thickness of 2000 Å with a thickness uniformity of better than 50 Å. The film permits reduction of the thin-film-transistor area in circuits such as LCDs, which increases brightness and resolution. It also allows integration of drivers and control electronics with low leakage current and high speeds in the TFT-matrix periphery on the quartz wafer. For more information, contact Andrew Wittkower of SOITEC/USA at (508) 531-2222. *DM*

HERMETIC PACKAGING COMES DOWN IN COST

Until now, reliable moisture protection for ICs and hybrids has been available in the form of costly hermetic packages. But Beckman Industrial Corp., Fullerton, Calif., has developed a polymer-encapsulated package that provides an affordable, reliable alternative to hermetics. The polymer coating resists corrosion and improves the durability of the circuits it encloses. Polymer-encapsulated packaging starts with an alumina-substrate base, to which ICs and other components are attached. The assembly is then encased in a solid polymer compound with a mold or retaining-ring frame. Lead frames or swagged pins complete the package. With no inner cavity, there is less of a chance for damaging moisture to collect or for loose-particle damage to occur. For more information, contact Beckman at (714) 447-2345. *DM*

CABLE ENABLES DANTE'S DESCENT

Recently, an eight-legged rappelling robotic explorer named DANTE II was lowered into Mt. Spurr, an Alaskan volcano, in hopes of gathering scientific data and demonstrating a system that holds potential for unmanned exploration of Mars and other planets. The robot, designed by Carnegie Mellon Robotics Institute, Pittsburgh, Pa., for NASA, underwent a redesign after an initial deployment into Mt. Erebus, Antarctica, failed in December, 1992. That effort was halted when a snag in the robot's umbilical tether line kinked the system's fiber-optic signal path, which elevated impedance in the line to an unacceptable level.

The cabling, which contained four critical signal lines, three power lines, and physical strength members, was redesigned by W.L. Gore & Associates, Newark, Del., and had to meet some unusual and severe environmental needs. Not only did the cabling have to withstand the

Xicor®

#6
Q3/94

Design Engineering Bulletin

New Product and Applications Information for Design Engineers

X88C75 SLIC® E^2 Microcontroller Peripheral adds I/O ports, E^2PROM, Static RAM, Interrupt controller and Address Decoding Logic to 80C31 Family

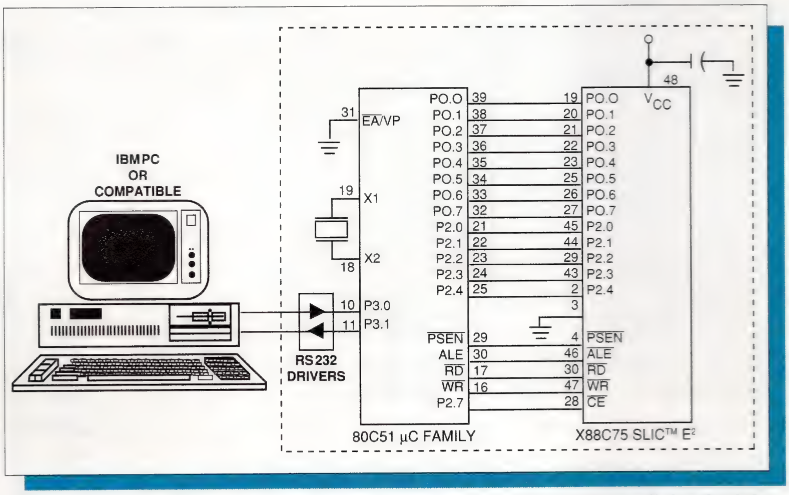
The X88C75 SLIC Microcontroller Peripheral is the ideal enhancement to 80C31 type systems. The device features 8K Bytes of E^2PROM which may be used for either program or data storage and 16 bytes of static RAM for data parameter storage. The sophisticated 16 I/O lines are configurable as either Inputs or Outputs with two additional strobing signals for either latching data into the ports or for strobing data out. The Programmable Interrupt controller can be configured to generate interrupts from either data input into the ports or the completion of the internal E^2PROM write cycle. The E^2PROM features concurrent read during write operation which allows the controller to continue program execution from the E^2PROM during a write cycle to the same device.

All internal resources are memory mapped and their location is programmable through the internal nonvolatile programmable decoder. This allows multiple X88C75 SLIC devices to be used to provide up to 64K bytes of E^2PROM, 128 Bytes of RAM and 128 I/O lines without any additional logic. The X88C75 SLIC device also features an optional LAM (Latched Address Mode) mode of operation where the 8- I/O lines of port B are used to output the de-multiplexed low order address byte of the 80C31 bus. This simplifies the inclusion of standard byte-wide memory devices such as SRAM, NOVRAM or EPROM into the system applications.

X88C75 Combines E^2PROM, RAM, I/O Ports and Interface logic into an integrated, cost effective E^2 Micropheripheral.

X88C75 SLIC Provides Complete Solution to Firmware in Embedded Systems

The need for software upgradability is becoming increasingly important in embedded systems. The X88C75 SLIC device provides a complete hardware and software solution to this need. The device is delivered with a small library of routines loaded into the device. Upon initial power-up, the 80C31 will be initialized, and the SLIC firmware will download the applications software through the UART on the 80C31. Subsequent downloads can be performed by re-invoking the SLIC firmware to allow the applications software to be changed once the system is in the field. The software update can be performed over an RS232 interface, a network connection, a local serial bus, RF link or a fiber optics cable. The updates may be performed in a random fashion allowing a single byte, numerous bytes or the entire applications program to be updated.



Upon initial power-up, the 80C31 will be initialized, and the SLIC firmware will download the applications software through the UART on the 80C31.

Designing systems based on the X88C75 SLIC E^2 is simplified by making the SLIC firmware routines readily available to the application software. A PC based program called XSLIC was developed to handle the X88C75 SLIC to host system interface. The XSLIC facilitates reconfiguration of the communication link parameters and downloading application programs to the target system. Provisions have also been made to relocate the SLIC firmware in case of address conflicts with on chip resources of the 80C51 derivative employed by the system.

Xicor and SLIC E^2 (Self Loading Integrated Code) are registered trademarks of Xicor, Inc.

Xicor, Inc. Marketing Dept. 1511 Buckeye Drive, Milpitas, California, 95035 Telephone (408) 432-8888 Fax (408) 432-0640

To receive this Design Engineering Bulletin, please use the reader service number or call: (408) 432-8888 Ext. 3336

READER SERVICE 254

Power-One

One power supplier for all reasons.

LINEARS

Produced in an ISO 9000 certified facility and agency certified to EN60950, Power-One linears continue to set the standards for performance.

MAP SERIES™

***40 to 130 watts** - This robust low-power switcher product line features autoranging, high power densities and superior regulation.*

NRG SERIES™

***250 to 550 watts** - Available in modular configurations with up to seven outputs or four-output non-modular OEM configurations.*

HIGH POWER

***500 to 2500 watts** - These modular products provide up to 21 outputs. Options include power factor correction.*

POWER-ONE™
POWER SUPPLIES

"Dedicated Supplier For Over 20 Years"

740 Calle Plano • Camarillo, CA 93012 • [800] 765-7448 • FAX [805] 388-0476

ISO 9000 CERTIFIED™

Call For Ou
Catalog Today

Power-One logo, NRG Series, MAP Series and ISO 9000 logo are trademarks of Power-One, Inc.

READER SERVICE 127

temperature extremes of volcanic lava and the Alaskan cold, but also it had to maintain mechanical and electrical reliability while supporting the 1700-lbs. robot as it rappelled into the volcano. Polytetrafluoroethylene (PTFE) was chosen for the cable's coax and twisted-pair dielectric material for its excellent electrical properties and ability to minimize cable diameters. For more information, contact W.L. Gore's Bob Rodriguez at (302) 738-4880. *DM*

SINGLE UNIX SPEC SHOULD EASE DEVELOPMENT

A single Unix specification (Spec 1170) will enable development of multiple, compatible implementations of the Unix computer operating system from different system vendors. To that end, a single Unix spec is being added to the X/Open Common Applications Environment specification set. Having one specification should reduce costs for software developers, who now maintain differing product versions for different operating systems. Following the publication process, the final specification is expected to be widely available this month. Companies wishing to comply with Unix specification and carry the Unix trademark may begin their submissions for formal X/Open branding. The first X/Open branded systems are expected early next year. For more information, contact X/Open Ltd., Menlo Park, Calif., at (415) 323-7992. *SVT*

STUDY PROVES FPIS SUPERIORITY

Recent data confirms that flat-panel inspection systems (FPISs) are superior in inspection time and quality over conventional human inspectors. This data, from a study by Photon Dynamics, Milpitas, Calif., suggests that future flat-panel displays may be assured of higher reliability. The study included 15 inspectors who were asked to detect defects on panels viewed at normal incidence, as well as off axis, at an optimum viewing angle. Over 90 possible combinations of pixel defects relative to the background of the panel were present.

An FPIS, Machine Vision, was also used to try and locate the 90+ defects. Results of the study suggest that the inspection system was either equal to or outperformed the human inspectors in most cases. Often, the inspection system detected defects two gray levels below those detected by the human inspectors. In addition, the average inspection time for the FPIS was considerably shorter than that for the human inspectors. Researchers believe this study will help to fully develop an FPIS that can detect, with greater sensitivity, even the smallest defect. Such a system offers the promise of more reliable, quality flat panels than was previously possible with human inspectors. Contact Photon Dynamics at (408) 433-3922. *CA*

EYE-TRACKING STUDY IMPROVES DISPLAY QUALITY

The formation of a digital-imaging-systems study group, a division of Texas Instruments, Dallas, Texas, heralds a marked change in the way projection displays are designed and developed. Researchers believe that the traditional engineering disciplines used to gauge display quality are no longer efficient or valid, in light of more advanced digital-display technologies. As a result, they are undertaking a project to study consumer visual perceptions and analyze how they determine the image qualities of displays.

The project consists of two test groups, one made up of experts and the other non-experts (or consumers). Both groups are presented with a series of images to evaluate, while each individual viewer's eye movements are recorded. This evaluation process is followed by a verbalization process, where the evaluation information is reviewed by the viewers and they are asked to recall their corresponding decision processes.

Based on the data collected from tests such as these, researchers have determined that experts and non-experts do not use the same criteria for determining image quality. Because non-experts, rather than experts, are the ones purchasing display products, the obtained data provides valuable information that will impact the design and evaluation of displays, ultimately allowing a more efficient, consumer-accepted display product to be produced. For further information, contact Texas Instruments at (214) 995-2011. *CA*

VIRTUAL REALITY COMES TO EYEWEAR

A renaissance in the virtual-environment display is now underway, thanks to the creative efforts of scientists from the Human Interface Technology (HIT) Lab, Seattle, Wash. Their work has focused on the development of low-cost, full-color, very-high-resolution image-display mediums. One of the more interesting developments to come out of this research is a virtual retinal display. The VRD consists of a conventional pair of eyeglasses, that when operable, will allow the wearer to view images projected directly onto the eye's retina. Early models of this device utilized two different scan-

SHARP

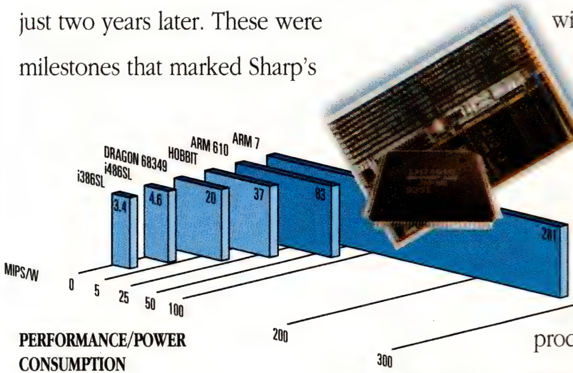
PROGRESS REPORT

Dedicated to the proposition that one good idea leads to another.

Thirty years ago, the closest an automobile might get to any kind of computing power was the exotic new electronic calculator in the dealership sales office.

That was about as close as automobiles got to *Sharp,* too: we invented the first all-transistor diode calculator in 1964, and incorporated ICs into calculators just two years later. These were milestones that marked Sharp's early inroads into the semiconductor, LCD and information communication technologies which, soon, no automobile will be without.

Today, Sharp is at the wheel of the advances in processing power, memory and display devices that bring the ultimate vehicle within sight: the autopilot, infobahn-ready automobile of the 21st Century.



PERFORMANCE/POWER CONSUMPTION

The ARM core is the most power efficient 32-bit RISC processor on the market today. It's also the world's smallest 32-bit RISC and, at less than $1/MIP for the ARM7, the most cost-effective.

THE FUTURE IS WITHIN ARM'S REACH.

For example, tomorrow's global positioning, auto-routing, auto-steer, voice recognition and collision-avoidance subsystems will owe a large debt to Sharp's new 32-bit RISC processors now being produced under the ARM® partnership. Low-cost, high-performance, fully supported microprocessors like the ***LH74610*** and ***ARM7 Core*** are making 32-bit performance practical in consumer products — from games and electronic books to interactive video and voice recognition.

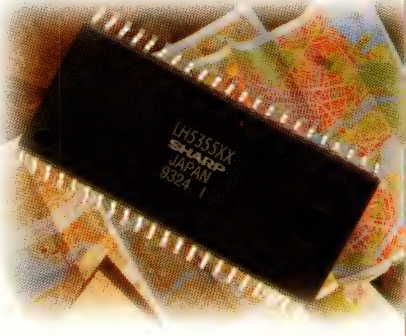
Our ***System on a Chip Design Center*** in Camas, WA, can help you roll out your product ideas quickly, using not only ARM technologies, but a wide variety of 4- to 32-bit microcontrollers and microprocessors. With our standard cell solutions and experienced design team, we keep your costs low and your options high.

From the basic calculator t

MEMORY: YOU CAN THINK BIG BECAUSE WE'RE THINKING SMALL.

By mating ARM and other microprocessors with an array of leading Sharp memory devices, you can achieve unduplicated efficiencies in data access, density and device throughput.

Recently, Sharp became the first manufacturer to offer ***8 and 16 Mb page-mode MROMs with 50 ns access times.*** That's performance comparable to the speed of EPROMs, but at *half* th price. And, to meet customers' memory-hungry but space-consciou design criteria, Sharp will also be the first to offer 64 Mb MROMs a well as 32 Mb MROMs in *both* 5-volt and 3-volt configurations.



Sharp's newest 8 Mb and 16 Mb MRO achieve their 50 ns access speeds by using a page-mode function that rea a page of information at once. Sharp offers an industry-leading 6 - 8 week turnaround time.

2-bit computing: Sharp keeps driving ahead.

DISPLAYS: TFT IS SHARP'S MOST VISIBLE ADVANTAGE.

harp is perhaps still best known
the leader in ***active matrix***
nd other flat panel displays.
rom personal digital assistants
the world's largest flat
anel full-motion monitors,
harp TFT displays are
elping lead the evolution
ward compact, portable displays
superb resolution, viewability
nd low power consumption.

Sharp's family of analog TFT
udio-visual displays range from
inch to 10.4-inch screen sizes
at are creating new realms of
roducts ranging from handheld
levisions to automotive navigation and in-flight entertainment centers. ISO-9000 certified flat panel facilities are already up and running right here in the U.S.A.

High contrast, wide viewing angle, up to 80 ms response rates and 16.2 million colors: nothing outshines Sharp TFT for high-quality displays in thin, lightweight profiles.

GET ARMED WITH 32 BITS FOR $249.

Right now, we'll send you the essentials of ARM development — software application manuals, data sheets, applications notes, ARM software and Design Center information — for just ***$249.*** We'll even include an ARM baseball cap, because we figure you'll soon be going to bat for ARM. Simply call us toll-free at **1-800-642-0261, Ext. 904.** And be sure to ask for our free Sharp Microcomputer Brochure covering our lineup of 4- to 32-bit microprocessors and microcontrollers.

Get this complete ARM software kit, including manuals, ARM software and more, for just $249.

SHARP®

FROM SHARP MINDS COME SHARP PRODUCTS™

READER SERVICE 149

FOR MORE INFORMATION CALL SHARP AT 1-800-642-0261 EXT. 904

pyright © 1994 Sharp Electronics Corporation.

SEC-0594

ners. Unfortunately, problems with limited scanning speed, direction, and bulky telescope-like optics, left these early designs short of expectation.

Recently, scientists developed a prototype that is based on a mechanical resonant scanner (MRS), which allows for rapid scanning in both directions in a miniaturized package. Such a system could find applications in medicine, education, and scientific visualization, as well as test, telecommunications, and visual entertainment. Phase one of this R&D effort was recently completed. Future efforts will look at ways to use the MRS technology to produce inexpensive, light-weight, fully immersible VRDs. Full development of the VRD technology is expected to be completed by 1998. Researchers believe these devices will one day render existing head-mounted virtual-reality systems, and state-of-the-art HDTV obsolete. For more information, call (206) 224-7499. *CA*

EXPERT SOFTWARE PROMISES FAST PROTOTYPES

Software developed by the National Institute of Standards and Technology (NIST) lends itself to rapid prototyping of manufacturing control systems. The the control system for a lab-scale process for making metal powders. The Expert Control System Shell, or ECSS, features a rule-based expert system to assist designers and a graphical user interface resembling a control panel. Designers can choose from among on-screen versions of push buttons, toggle switches, slide controls, and other types of actuators. User-interface options for displaying process data include dials, charts, and graphs. The control system can be operated manually or under the expert system's command. With further refinement and testing, the software could be used to build control- system architectures for other types of dynamic manufacturing processes, as well as be adapted to other computer platforms. For more information on the software, contact Steve Osella at NIST, (301) 975-4263; e-mail via Internet: osella@cme.nist.gov. *SVT*

INDEX-MATCHING IMPROVES LCDS

A problem in liquid-crystal displays for avionics, known as dc plating or the "white-shirt" effect, has been nearly eliminated by a technique called thin-film index matching. The technique, developed by Crystaloid, Hudson, Ohio, achieves better uniformity between indium/tin oxide (ITO) electrodes that carry current in the LCD and the display's background. The so-called "white-shirt" effect refers to instances in which an aircraft's pilot sees the ITO electrodes when light is reflected from the pilot or co-pilot's white shirt. When this occurs, inactive segments of the display may appear active, causing misinterpretations and possible errors.

To solve the problem, an index-matching coating is applied over ITO and non-ITO areas of the display to match reflections generated in both portions of the display character. Specular reflection contrast with the coating becomes virtually zero. Most avionics applications require that the contrast between ITO and non-ITO areas, when measured specularly, be less than 0.4. In addition to improving visual properties, the index-matching technique prevents dc plating, a condition which causes electrical shorts as current moves from the front to the back planes of the glass in the LCD. It does so simply by providing a physical barrier that prevents migration between electrodes. For more information, contact Ed Surjan Jr. at (216) 655-2429. *DM*

OBJECT TOOL WORKS WITH REAL-TIME DESIGNS

As real-time applications become more complex with ever more threads (or tasks) to execute, tracing the execution of these threads becomes ever more desirable. Version 2.0 of SES/objectbench from SES in Austin, Texas, supports the Shlaer-Mellor method of object-oriented analysis, including simultaneous execution of multiple subsystems. With this capability, designers can test the interaction of subsystems and verify the completeness and accuracy of design. The new release is integrated with SES/workbench, the company's system design and performance modeling tool. Objectbench 2.0 is slated to ship at the end of September on various Unix platforms; a port to Windows NT is slated for next year. For more information, contact the company at (512) 328-5544; fax (512) 327-6646. *SVT*

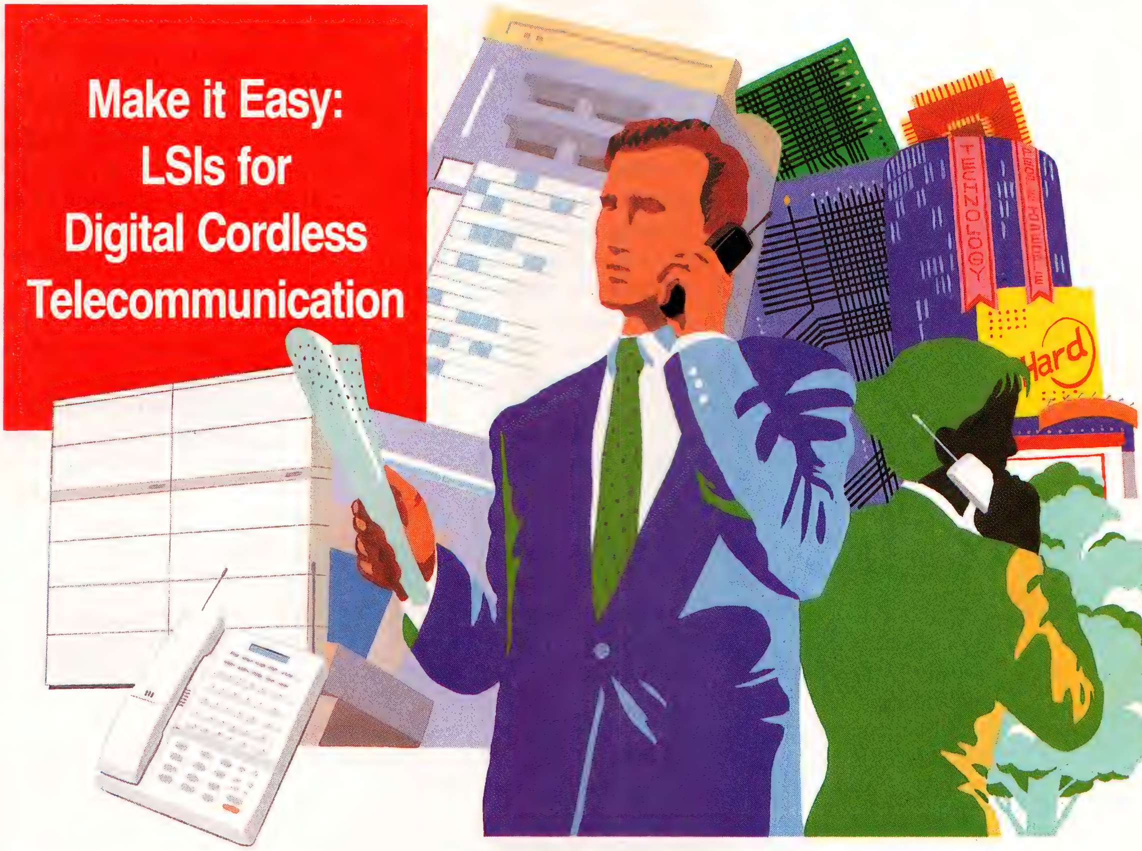
ADVANCED BATTERY RESEARCH CONTINUES

As part of a two-year, $600,000 research project sponsored by the Department of Energy and aimed at supporting advanced battery technology development, Advanced Research Technology, Buffalo, N.Y., will investigate the merits of porous aluminum-nitride (AIN) fabrication. In the hopes that this effort will have a significant energy-related impact, the New York State Energy Research and Development Authority has also pledged to contribute an additional $125,000 to the research.

LED PRINT HEADS MEMORIES MEMORY MODULES MICROPROCESSORS MICROCONTROLLERS MEMORY CARDS

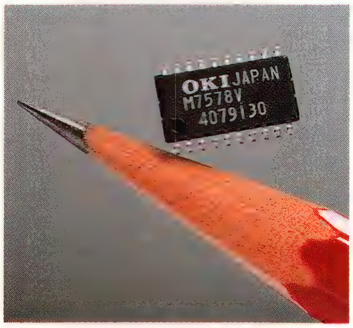
IC CARDS ASICS VOICE SYNTHESIS LSIs LCD DRIVER/CONTROLLERS VF DRIVER/CONTROLLERS TELECOM LSIs OPTOELECTRONIC DEVICES GaAs DEVICES

Make it Easy: LSIs for Digital Cordless Telecommunication



Oki telecom LSIs benefit from our pioneering experience in cellular and cordless telephones. Low power and exceptional sound quality make them suitable for use in digital cordless phones (CT2, PHS, DECT, etc.), ISDN terminals, PABX systems and more. Features include:

·Single-rail operation ·TSOP package availability ·Independent transmit/ receive channels



Parts and Partnership

Oki's advanced IC family is fully backed by customer-oriented flexibility and prompt follow-through at every stage, from design to manufacture.

MSM7578/79 *Small footprint, single-rail, 5V ADPCM CODEC in 20-pin SSOP.*

Part No.	Supply voltage	Companding law	PCM CODEC G.714	ADPCM CODEC G.721	Master clock freq.	Status
MSM7566/67	2.7-3.8V	7566/μ-law 7567/A-law	○		not needed	M.P.
MSM7543/44	4.75-5.25V	7543/μ-law 7544/A-law	○		not needed	M.P.
MSM7578H/7578V/7579	4.75-5.25V	7578H/μ-law 7578V/μ/A-law selectable 7579/A-law	○		not needed	M.P.
MSM7570	4.5-5.5V	μ/A-law selectable	○	○	7570, 19.2/12.288MHz	M.P.
MSM7570L/90L	2.7-3.6V				7590, 10.368MHz	

OKI

People to People Technology

For more information, contact:

Oki Electric Industry Co., Ltd.
Electronic Devices Group
Overseas Marketing Dept.
5-25, Nishishinjuku 7-chome
Shinjuku-ku, Tokyo 160, Japan
Tel: 81-3-5386-8100 Fax: 81-3-5386-8110

Oki Electric Europe GmbH
Head Office
Hellersbergstraße 2, D-41460 Neuss
Germany
Tel: 49-2131-15960 Fax: 49-2131-103539
Telex: 8517427 OKI-D

Oki Electronics (Hong Kong) Ltd.
Suite 1801-4, Tower 1, China Hong Kong City
33 Canton Road, Tsim Sha Tsui, Kowloon
Hong Kong
Tel: 852-7362336 Fax: 852-7362395
Telex: 45999 OKIHK HX

REED RELAY/REED SWITCHES OPTICAL MOS RELAYS LED PRINT HEADS MEMORIES MEMORY MODULES

MICROPROCESSORS MICROCONTROLLERS MEMORY CARDS IC CARDS ASICs VOICE SYNTHESIS LSIs LCD DRIVER/CONTROLLERS VF DRIVER/CONTROLLERS

READER SERVICE 125

This project is phase two of an early effort that successfully demonstrated the suitability of sintered AIN materials for separators in lithium-metal sulfide (LiMS) batteries. It is specifically aimed at providing a sintered AIN product that is technically and economically suited for the LiMS battery. As part of this effort, Advanced Research Technology will pursue performance optimization in conjunction with cost reductions for the separator. To this end, extended battery testing will be performed to assist in separator plate optimization and to develop baseline characteristics for baseline development.

All optimized AIN separators will be evaluated by a domestic, commercial LiMS battery fabricator in preparation for commercialization of the concept. Included in this effort will also be the identification and investigation of methods for decreasing the overall cost of AIN separators. Three such areas of possible cost reduction include powder cost, tape-processing improvements, and continuous firing options. Potential commercial applications for the AIN separators include a number of advanced batteries, such as LiMS. Military applications include opportunities for this technology in weaponry and emergency power battery systems. For further information, contact Mary Spohn of Advanced Research Technology at (716) 875-4091. *CA*

FCA LOOKS FOR PARTNER IN JAPAN

The Fibre Channel Association (FCA), Austin, Texas, is looking to establish a partner organization in Japan. The association's effort, coordinated by Hucom, Tokyo, will initially attempt to establish a work group to serve as a focal point for the Japan FCA organization. The group's objective will be similar to that of its U.S. counterpart—to promote industry awareness, acceptance, and advancement of fibre-channel technology.

Fibre channel is a communications interface that allows for cost-effective, concurrent communications among workstations, supercomputers, mainframes, data-storage devices, and other peripherals. Such an interface provides for high-speed internetworking and interoperability.

The communications interface is used in data-intensive applications, such as the transmission of real-time, full-motion video, multimedia, imaging, and simulations. Its key features include high bandwidth, support for both copper-wire and fibre-optic media, the ability to carry information simultaneously in both directions, error-detection mechanisms in hardware, and superior flow-control characteristics. These features combine to give users the flexibility of large amounts of data transmission at increased rates.

Over the past few years, fibre-channel technology has seen increasing interest with a number of Japanese companies. The Japan-FCA organization will directly address this interest, as well as help to facilitate the downloading of information regarding the technology to industry members. For further information, contact Carolyn Colin of the Fibre Channel Association at (714) 932-7435. *CA*

ADVANCED SEISMIC SENSORS NOW UNDER DEVELOPMENT

Under a cooperative research and development agreement (CRADA), between Teledyne Geotech, Garland, Texas, and Sandia National Laboratories, Albuquerque, N.M., attempts are being made to prototype state-of-the-art seismic sensors with an advanced mechanical design and new technology transducer. The sensors will be optimized for operation over a broad frequency band.

The development of such a broadband sensor is vital for applications that require the monitoring of high seismic-wave frequencies, such as the monitoring of potential underground nuclear-weapons testing during treaty verification. Currently, no instruments are available that can operate over a large enough frequency range of interest. Hence, multiple instruments are often required. It is anticipated though, that a seismic sensor that combines the capabilities of multiple sensing instruments into one instrument can be developed through optimization of the sensor transducer, made by Teledyne Geotech.

Such a major advance in seismic sensor technology could conceivably provide for a broadband portable sensing solution that would effectively decrease installation complexity and interface with advanced data and processing techniques. Additional applications for this technology include nuclear proliferation monitoring, and earthquake detection and monitoring. For more information, contact Sandia National Laboratories at (505) 844-6367. *CA*

Because you're thinking fast...

Pick your path to affordable high speed op amps.

Low harmonic distortion.

To reproduce your high-speed input signals with the greatest signal purity, choose from op amps such as the 350MHz CLC409, which delivers -65/-72dBc 2nd/3rd order harmonics at $2V_{pp}$, 100Ω, 20MHz. Plus a half dozen others with less than -50dBc distortion.

Fast settling time.

Our wide range of high-speed op amps gives you a choice from 8-bit to 14-bit settling. They range from the 350MHz CLC409 with a fast 8ns to 0.1% to the 195MHz CLC402 with a blazing 18ns to 0.0025%.

Low power consumption.

Want high speed with low power? Choose from op amps like the 350MHz CLC409 with 135mW power dissipation, the 160MHz CLC406 at 50mW, the 300MHz CLC420 at 40mW, or the 50MHz CLC505 at 10mW, which lets you set supply current over a range of microamps to milliamps with a single resistor.

Low offset voltage.

A half-dozen high-speed op amps give you V_{os} of less than 1mV. For example, the 1.7GHz GBW CLC425 delivers a low 100μV offset. The CLC402 and CLC409 provide V_{os} of 500μV. And nearly a dozen other fast op amps have less than 2mV offset.

Low noise.

With its ultra-low $1.05\text{nV}/\sqrt{\text{Hz}}$ input noise, the CLC425 is the lowest-noise wide-band op amp on the market. Close behind is the unity-gain stable CLC426 with $1.4\text{nV}/\sqrt{\text{Hz}}$ input voltage noise. Followed by more than a dozen with e_n less than $3.0\text{nV}/\sqrt{\text{Hz}}$.

Wide bandwidth.

Choose from our large family of dc-coupled wideband op amps. From the 55MHz CLC430 and the 350MHz CLC409 current-feedback op amps, to the 1.7GHz GBW CLC425 and the 5.0GHz GBW CLC422 voltage-feedback op amps.

High gain.

Our large family of current-feedback op amps deliver nearly constant bandwidths over their gain ranges. For example, the CLC401, at a gain of +20V/V, gives a 150MHz -3dB bandwidth. And the voltage-feedback CLC422, with its 5.0GHz GBW, delivers the widest gain bandwidth product on the market.

Fast slew rate.

Speed is our specialty, so you'd expect performers like the 175MHz CLC404, which delivers 2600V/μs and a $5V_{pp}$ output signal. Or the 200MHz CLC411, a 15V op amp at 2300V/μs. Plus nearly a dozen more with specs greater than 1000V/μs.

Prices you can afford.

Pricing on our high-speed op amps is very competitive. And you'll find significant quantity discounts. Take a look, because we have dozens of fast op amps to choose from. Plus applications engineers that are ready to help you with product selection and design troubleshooting.

For details, call or fax our European sales office and ask for our new "Solutions with Speed" data book and FREE macromodels. Then you can explore your own path to high speed.

Comlinear Corporation

Solutions with speed

4800 Wheaton Drive
Fort Collins, CO 80525
(303) 226-0500
1-800-776-0500 (USA)

For more information, Contact Comlinear Europe Ltd.
15 Mercia Business Village, Westwood Business Park, Coventry
CV4 8HX, England. Phone 44 203 422958, Fax 44 203 422961

© 1993 Comlinear Corporation

READER SERVICE 280

NOT THE SA

The World's First
17MHz Rail-to-Rail
I/O Op Amp (@ I_S = 650µA)

The LM6142 / 4 ~ Ultra-high gain-bandwidth of 17MHz @ 50KHz while drawing just 650μA of supply current @ +5V ~ Rail-to-rail input and output ~ Guaranteed single-supply performance ~ Excellent DC precision (Vos of 1mV; CMRR of 107dB) ~ Operates from +1.8V to +24V supplies ~ Low voltage noise (e_n=13nV/$\sqrt{Hz}$ @ 1KHz) ~ For a free product sample kit and ordering information, call **1-800-NAT-SEMI, Extension 305.**

National
Semiconductor

©1994 National Semiconductor Corporation. NORTH AMERICA: P.O. Box 7643, Mt. Prospect, IL 60056-7643 (Tel: 1-800-628-7364, Ext. 305 Fax: 1-800-888-5113). All rights reserved.

ADVANCED FPD PROCESS IS IN THE WORKS

Coloray Display Corp., Fremont, Calif., and Sandia National Laboratories, Albuquerque, N.M., have combined their resources to develop an advanced flat-panel-display (FPD) manufacturing technology. As part of this $2.6 million, three-year effort, they will jointly develop an advanced-manufacturing technology that will potentially result in revolutionary improvements in the proprietary manufacturing processes and technology used in Coloray's flat-panel display products. The research will specifically focus on the design, development and manufacture of field-emission-based flat-panel-display products with superior performance and lower manufacturing costs.

As part of this project, researchers from Sandia National Labs will use their technical expertise in collaboration with Coloray's thin-film capability to fabricate new and unique thin-film structures required for improved display performance and manufacturing yield. In addition, their joint expertise in thin-film deposition will be used to investigate alternative display-fabrication techniques. It is hoped that the research will lead to reductions in the time and cost to bring field-emission-based FPD products to market. Contact Charles Antony of Coloray Display Corp. at (510) 623-3300. *CA*

COLOR HOLOGRAMS EDGE CLOSER TO REALITY

Full-color, three-dimensional, lifelike photographic images—a.k.a. holograms—are quickly becoming a reality. This is partly the result of the research and development efforts of Dr. Hans I. Bjelkhagen, well-known holographer and vice president of American Propylaea Corp., Birmingham, Mich. Current holographic techniques are limited solely to monochromatic images. Using a technique developed by Dr. Bjelkhagen, though, holographic techniques now have the option of full-color, in addition to monochromatic images.

This development promises to create a revolution in a number of industries, including automotive, medical imaging, advertising, and marketing. Currently, much attention is focused on the transfer of this technology to the automotive industry in an attempt to develop large-scale, full-color holograms for the purpose of reducing the overall time from design to market. Initial estimates suggest that by using full-color holographic images, new cars could be designed and brought to market in 20 months, as opposed to approximately 45 months, using conventional technology. For further details, contact American Propylaea Corp. at (810) 642-7000. *CA*

ARPA SPONSORS CONTINUE R&D PROGRAMS

The National Center for Advanced Information Components Manufacturing (NCAICM), Albuquerque, N.M., a collaboration between ARPA and the U.S. Department of Energy, is currently undertaking 25 new projects in from flat-panel displays and microelectronics, to optoelectronics and advanced lithography. Such research could be beneficial in speeding the time to market for U.S.-developed advanced-information components.

One key project focuses on the development of an automated system of active structural controls for advanced lithography equipment. Such a system could potentially lead to the reduction of possible vibrations introduced during the manufacturing process. In addition, this automated damping system could help reduce any of the imperfections or waste that occur during manufacturing, as well as improve overall manufacturing productivity.

Another area of research and development, vital to the microelectronics industry, focuses on the design and fabrication of sensors for the detection of contamination, and the measurement of defects during the manufacturing process. Such devices could have broad applications for use in better understanding and resolving problems associated with manufacturing both microelectronic devices and flat-panel displays.

It is hoped that these research and development efforts of NCAICM will assist in providing U.S. microelectronics manufacturers, as well as the emerging flat-panel-display industry, an opportunity to increase their competitiveness in the world marketplace. For more information, contact Jim Jorgensen of NCAICM at (505) 844-1023. *CA*

Accept no substitutes.

CHOICES. We offer you three distinct families of antifuse FPGAs that provide more than 300 different combinations of speed, density and packaging. So you never settle for less than you need—or pay for more than you want. Also, to ensure you a plentiful supply at competitive prices, we've added Arrow Electronics worldwide to our list of distributors, which in North America includes Pioneer and Wyle.

FAST AND PREDICTABLE. The Actel antifuse is a very low RC interconnect element. And our patented segmented routing offers almost any length of routing track, which minimizes RC for any chosen path. The result is fast, predictable timing, even at high capacities. You get fast logic, such as 167 MHz counters and datapath and 7.5 ns clock-to-out speeds. Which lets you achieve fast designs like 100 Mbit Ethernet receivers, 100 MHz graphics controllers, and 50 MHz DRAM and DMA controllers.

AFFORDABLE. The special combination of the Actel antifuse and channeled architecture gives you the best value in logic today. Our antifuse element is far smaller than competitive switching technologies, delivering greater capacity and more functionality in smaller die sizes. And less silicon equals lower costs. Plus, our channeled architecture lets you use more of the available logic on every chip.

EASY TO USE. Our highly automated Designer Series can cut days, weeks or even months off your design cycle. Our automatic placement and routing tools let you make last minute design iterations with minimal compromises. Recent additions include ACTmap™ FPGA Fitter, a logic synthesis and optimization tool, ACTgen™ Macro Builder, a powerful parameterized macro function generator, and ChipEdit, the first of our new generation of graphical design tools created especially for the Windows™ and X-Window environments. All of which are fully integrated within our core Designer system.

FLEXIBLE. Actel FPGAs and design tools give you the freedom to shrink all or some of your system's logic onto a single programmable device. Only Actel really lets you fix your I/O pins before you've finished your design, so that work can progress on other parts of your system. You get all that, plus high gate utilization, thanks to the plentiful routing resources that are an inherent part of our antifuse technology.

SYNTHESIS FRIENDLY. Our antifuse and channeled architecture give you small, homogeneous logic modules, which make our FPGAs extremely well suited to high-level design techniques such as HDL/VHDL and synthesis. In addition, we've assured that the most popular HDL/VHDL and synthesis tools work with our architecture—including tools from Cadence™, Exemplar, IST, Mentor Graphics®, Synopsys®, and Viewlogic®.

Specify only original, genuine antifuse FPGAs from Actel.

In 1988, we pioneered the first antifuse FPGAs. Since then, we've continued to expand our technology to give you even greater speed, capacity and design flexibility. Today, nobody can match the fast, flexible design of Actel FPGAs because nobody can duplicate our technology. We hold 40 patents on our antifuse and channeled architecture alone.

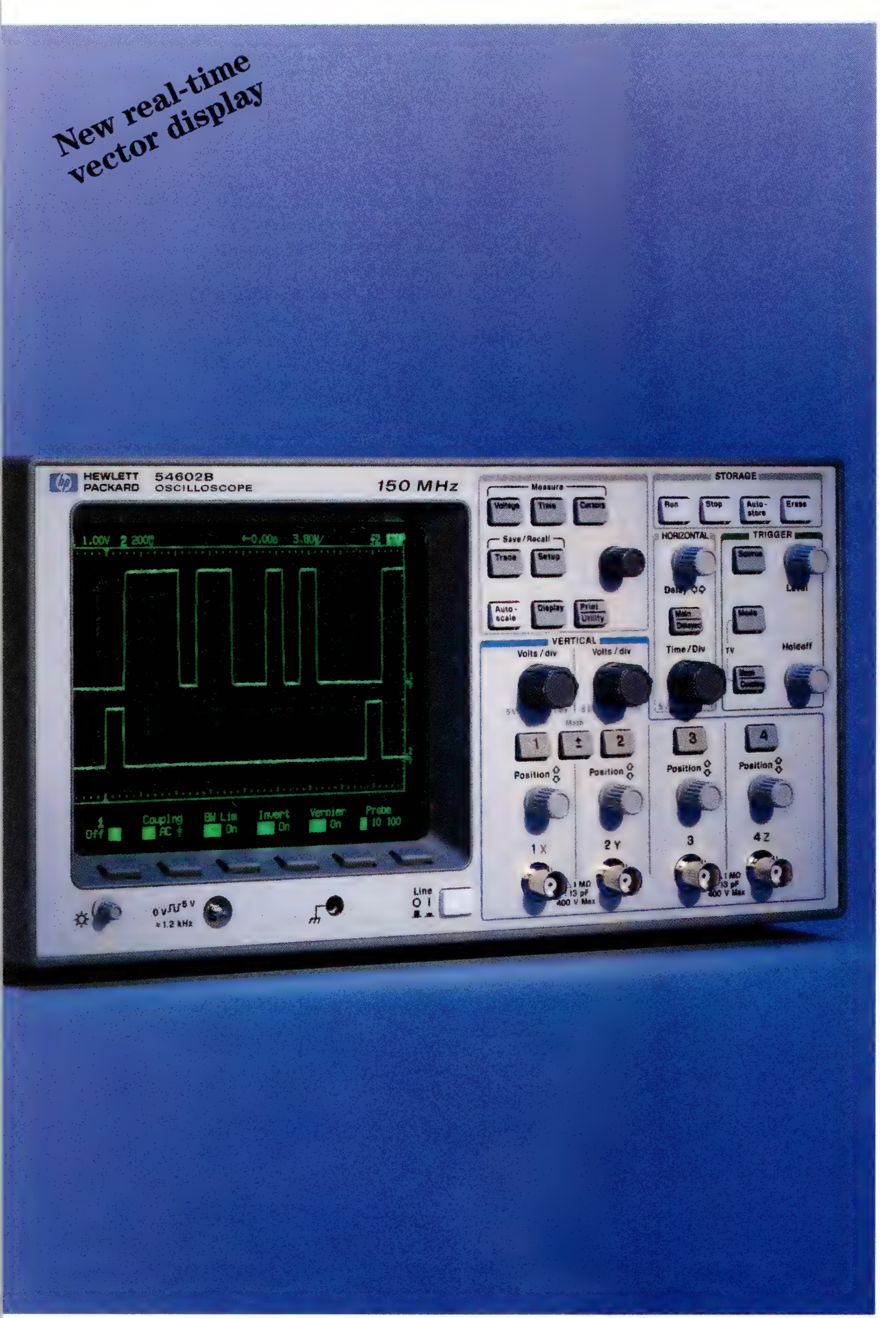
With microprocessors and memory increasingly standardized, logic design may be the only area where you can differentiate your product. So don't risk your design on anything less than the genuine article: Actel antifuse FPGAs. For information, call 1-800-228-3532. You'll agree, there's no substitute for the real thing.

Actel

955 East Arques Ave., Sunnyvale, CA 94086-4533
1-800-228-3532
908-225-0700 (outside North America)

CIRCLE 275

Within budget. Without compromise.



The value of this scope is easy to see.

Take a close look at the HP 54600-series oscilloscopes, and you can't help but notice certain things.

It looks and feels like an analog scope, with dedicated knobs and a display that responds instantly to your control changes. Yet it has all the digital power that analog can't give you — high accuracy, automatic measurements, hard copy output and programmability. And superior viewing of virtually any waveform, even at low rep rates and slow sweep speeds.

But what really stands out is that the HP 54600-series scopes give you all this performance at a great price. Four models ensure you get the right scope for your measurements. The HP 54600B 100 MHz (2-channel). HP 54601B 100 MHz (4-channel). The HP 54602B 150 MHz (4-channel). And the HP 54610B 500 MHz (2-channel).

☎ **For more information, call your local HP sales office or one of the numbers listed below.** We'll be happy to send you literature about the HP 54600-series scopes.

There is a better way.

HEWLETT® PACKARD

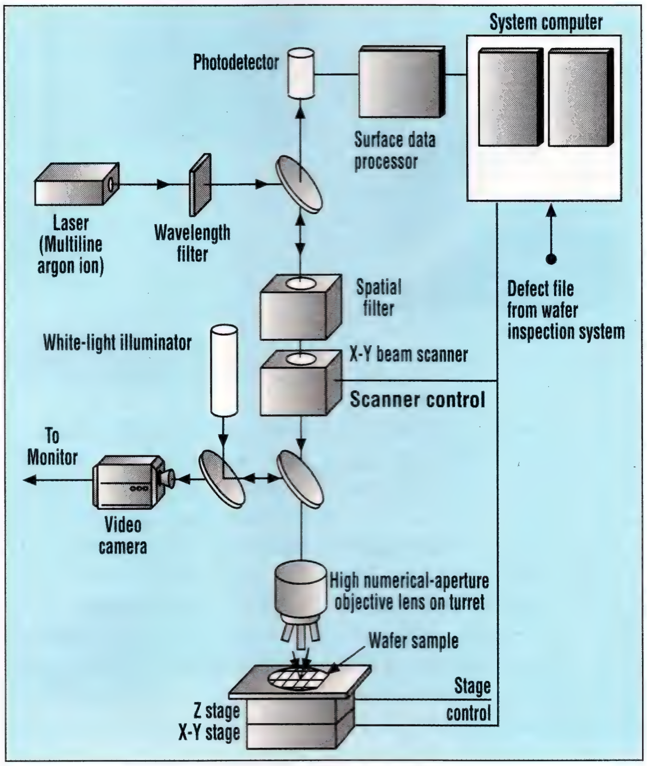
© 1994 Hewlett-Packard Co. TMPMO452/SF33

Australia (008) 033-821 • Austria (0660) 8004 • Belgium (02) 778-3417 • France (1) 69-82-60-20 • Germany (07031) 14-6333
Hong Kong (852) 599-7070 • India (11) 463-2379 • Ireland (01) 2844-633 • Italy (02) 92-122-241 • Korea (2) 769-0800
Netherlands (020) 547-6222 • PRC (1) 505-3888 • Singapore 291-8554 • Spain (91) 631-15-02 • Sweden (08) 750-2277
Switzerland 01/735-72-00 • Taiwan (2) 717-9524 • United Kingdom (0344) 366666

READER SERVICE 258

LASER-SCANNING SYSTEM OFFERS REAL-TIME IMAGING AND REVIEW OF WAFER DEFECTS

The escalating need for semiconductor processing in various electronic products has forced chip makers to meet ever higher standards of performance and yield. In addition, the development of 256-Mbit DRAM and ULSI devices has promulgated increasingly complex wafer sub-geometries and decreasing IC line widths. Semiconductor processing now takes place in 400 steps instead of 100, making particulate and etch defects practically invisible. Needless to say, all of these factors has underscored the need for a quick and effective system that will provide on-line scanning of wafer defects.



By integrating a number of advanced technologies, this need now can be fulfilled with a real-time laser-scanning inspection tool. Developed by Ultrapointe Corp., San Jose, Calif., the Laser Imaging System (LIS) boasts advanced process control and the ability to identify defects of 0.1 and 0.3 µm in diameter.

Conventional inspection systems, whether based on simple microscopes or scanning electron microscopes (SEMs), have served as the solutions to these problems for a number of years. Such systems, while effectively allowing product wafers to be scanned for anomalous optical sites, characteristic of defects, are plagued by a number of significant problems. Microscope inspection stations, for example, are unable to meet the growing demands of semiconductor processing. And SEMs typically are more appropriate for laboratory applications due to limited wafer throughput and the potential for wafer damage.

All conventional inspection stations seriously lack sufficient resolution to identify small artifacts or structures of 0.1 to 0.3 µm in diameter. Though they're able to determine the density of wafer defects, they can't accurately identify their nature or exact location. Consequently, the semiconductor industry has been left looking for a cost-effective, non-destructive instrument with the ability to "revisit" and positively identify defects.

One solution, as identified by Ultrapointe's scientists, is based on the principles of confocal microscopy. This technology, when integrated into the LIS, provides for a tool that can "revisit" a problem site already identified by conventional means, and provide detailed information on particular types of defects. Such information is invaluable in accessing defect characteristics, wafer damage, and yield throughput. Fully automated and requiring less than 1 hour of training for an inspector to operate, the LIS in its basic mode offers performance and reliability at a moderate cost and with a two-fold acuity improvement.

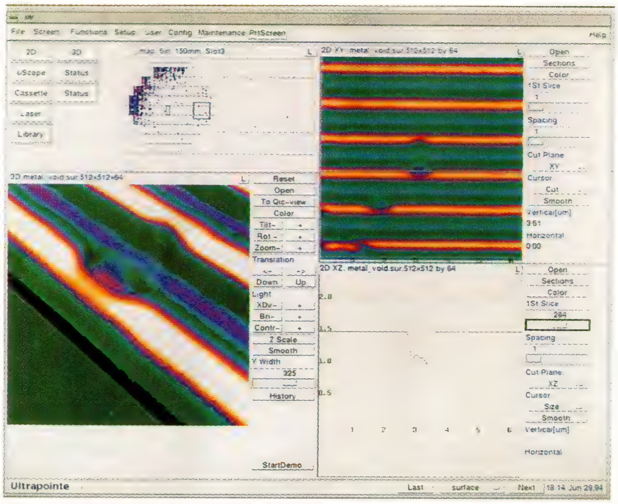
One of the key features of confocal microscopy is its ability to nondestructively depict relatively high resolutions of approximately 0.1 µm. On top of that, it allows samples to be inspected in their own natural environment. As a result, it facilitates high throughput in production situations and minimizes any possible artifacts caused by sample preparation for inspection using other inspection techniques.

The confocal technique, at the heart of the LIS operation, is based on the use of a point source of light, from an air-cooled, multiline argon laser, sharply focused to a diffraction-limited spot on a sample *(Fig. 1)*. The reflected light is viewed through a spatial filter that isolates the viewing area coinciding with the illuminating spot. Thus, the illumination and detection apertures are optically conjugated with each other.

The spatial filter also filters out all light except that coming from the focal plane of the objective lens, resulting in a very small 0.5-nm depth of field, increasing sensitivity. A photodetector measures the intensity of the light reflected by the sample and produces a high-contrast image, formed only with the in-focus light.

The diffraction-limited laser spot is typically raster-scanned at video rates across the sample. The photodetector's entire output is digitized using 256 gray levels and collected for later processing to build an image of the sample. Because the sample is mounted on a precision stage, it can be moved to a new Z-axis location, after the X- and Y-axis scan. This process may be repeated many times. All obtained digitized data then can be combined into a three-dimensional surface image using a high-speed data processor.

These images provide vital information not only regarding the size and spatial relationships between various features, but also in identifying defects such as particles, pits, scratches, and masking defects. With the high-resolution images generated by LIS, as well as its ability to see below the surface of transparent layers, there's no limit to



the depth of information it can provide.

The actual operating system has two main components—an operator console and a laser optics unit. The console, which executes all system control from multiple user-configurable windows, may be located remotely from the laser-optics unit, allowing for greater system flexibility.

The system computer consists of menu-driven software screens, scroll bars, and push buttons, geared toward making the system user-friendly. Multiple windows allow the operator to look at several digital images, such as 3D surfaces, profiles, and Z-direction slices, simultaneously *(Fig. 2)*. The optics unit relies on its automated X-Y drives and wafer handling to conduct all computer-executed processing steps. Wafers ranging in size from 75 to 200 mm can be processed without contamination.

Combining automated robotic wafer handling, integrated automated stages, and dedicated software tools, LIS can control defect identification, archiving, and communication. It interfaces with all commercial wafer-inspection systems and centralized fab databases. Its small footprint makes it easy to integrate into any fab. Moreover, the LIS, according to Utrapointe, outperforms SEMs in cost of ownership and clean-room capability.

The basic LIS model, the LIS-500, is specifically designed as an automated system for use on production lines. It can be upgraded to either the LIS-1000 or LIS-2000 to offer a variety of higher-level functions.

The LIS-1000 offers a marked improvement in resolution of 2D and 3D images. It also features high-resolution optical and laser images, as well as image manipulation and profiling. The LIS-1200 adds speed and integrated imaging to the LIS-1000 package. Moreover, it combines full-white-light and laser-imaging capabilities through the same optics, providing greater capability to locate even the most obscure defect in a timely manner.

For further information and cost details, contact Ultrapointe Corp. at (408) 894-7080.

CHERYL AJLUNI

MULTILEVEL CHARGE-VALUE SENSING SCHEME DOUBLES FLASH-MEMORY STORAGE DENSITY

Advances in memory density often come as a result of fine-line lithographic processes that shrink the memory cells, or through innovative memory cell structures that reduce the area for each bit. However, a new scheme, which can double the bit density without disturbing the lithography and physical-cell design, promises to make flash-type nonvolatile memories much more price-competitive with other memory approaches.

The scheme, called the multilevel cell, uses a charge-sensing technique to detect various values of charge stored on each floating gate. These values then are used to quantify the contents of the cell into two bits rather than a single bit. In standard flash memories, the floating gate is considered programmed when the charge on the gate reaches a minimum threshold value, V_t, or any level above that threshold. However, using a single threshold level limits the cell to representing a single bit of stored data.

The multilevel cell scheme, developed by Intel Corp., Santa Clara, Calif., sets up four threshold voltage windows between the value of 0 and V_t *(see the figure)*. Each threshold window represents one of four progressively higher 2-bit patterns of stored data—00, 01, 10, or 11—as the voltage increases from 0 to V_t maximum.

Storing multiple bits using multilevel charge sensing isn't a new concept, however. Over a decade ago, a multilevel charge-sensing scheme, referred to as "stratified charge," was proposed for DRAMs in a paper at the IEEE International Solid State Circuits Conference. Information Storage Devices Inc., San Jose, Calif., currently uses an analog form of the multilevel-charge scheme to store and playback audio.

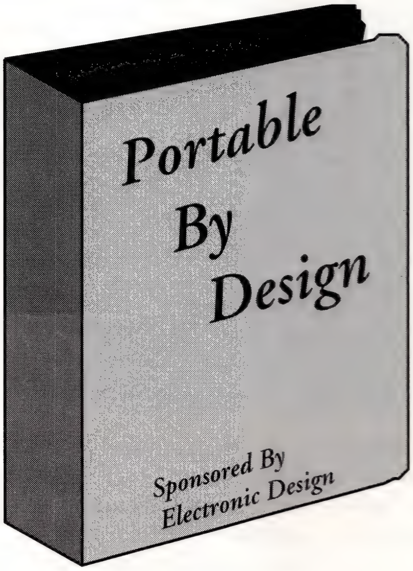
To set the various V_t windows, Intel starts by setting a reference point of $V_t/2$. For the sake of clarity, it will be called reference voltage 1 (V_{R1}). Charge-detection circuits then can easily decide if the charge value is above or below the V_{R1} level, which determines the value of the first bit. That's the same function performed by single-bit/cell floating-gate sense circuits. But in Intel's scheme, the midpoint of each window (0 to $V_t/2$, or $V_t/2$ to V_t) has a second reference voltage, V_{R2}. A second comparison of the charge value is made to determine if the charge value is above or below the V_{R2} level, establishing the value of the second bit.

The key to this scheme is the on-chip circuitry's ability to reliably sense the charge value in each cell and ascertain which bit pattern the charge represents. To perform the sensing, new finer-grain detection circuits must be included on the chip. The multilevel comparisons require more precise manufacturing and very tight tolerance control to ensure that the voltage-threshold windows line up properly and remain stable over time and temperature.

Stability is key to the vi-

Proceedings of Portable By Design

Sponsored By Electronic Design Magazine

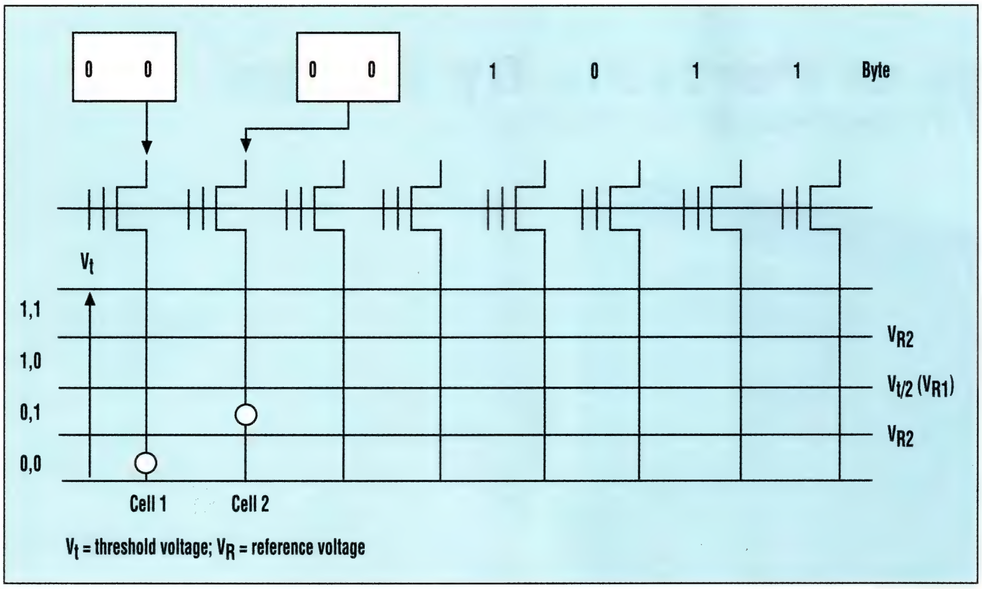


Price $150.00 per copy (add $12.00 shipping & handling per copy)

A conference for OEM Designers of portable, nomadic, mobile, transportable and hand-held products. The product areas covered in these proceedings include almost 800 pages of information on:

* Power Circuits
* Connectivity
* Input Devices
* Managing Mechanical/Electrical Design Teams
* Expandability/Configurability
* Engineering The Whole System
* High End Microprocessors
* Low-Power Microncontrollers
* Power Management
* Application Development & Operating Systems
* Batteries
* Displays

For additional or ordering information, please call (201) 393-6075



V_t = threshold voltage; V_R = reference voltage

ability of the cell charge-sensing scheme, because instead of dealing with a substantial threshold voltage in one measurement window, the new scheme must deal with four windows that use one quarter of the threshold voltage. Dr. Stefan Lai, the director of flash technology at Intel, expects that the process technology now in place can readily handle the challenge to set up four stable windows, turning 16-Mbit chips into 32-Mbit memories with minimal changes to the overhead circuitry. Although no product is expected soon, reliability studies are showing great promise.

Furthermore, Dr. Lai feels that the technique could be extended further to store additional bits per cell. However, to store four bits, for example, 16 windows would be needed. That would require extremely tight tolerances on very-small-threshold windows, something today's processes can't handle. But by the turn of the century, improving multilevel technology could make possible 1-Gbit/chip floating-gate nonvolatile memories with mature 256-Mbit processes.

DAVE BURSKY

ARE 100-GHZ-F$_T$ SILICON-GERMANIUM HBTS FOR REAL? FIND OUT AT THE BCTM

Previously, at two separate conferences (the International Electron Devices Meeting and the International Solid State Circuits Conference), Analog Devices and IBM announced and described a unique silicon-germanium (SiGe) bipolar process capable of challenging gallium arsenide's speed and bandwidth (ELECTRONIC DESIGN, *Dec. 2, 1993, p. 48, and Feb. 7, 1994 p.47)*. The process allows the fabrication of SiGe heterojunction bipolar transistors (HBTs) with f_ts reaching over 100 GHz and beta-Early-voltage products in the tens of thousands at collector-emitter voltages under 3 V (high beta-Early-voltage products are virtually mandatory for high-performance analog circuits). The lingering question, though, is whether or not this process has a commercial future. Are the transistors and ICs it has created (for example a 12-bit, 1-GHz digital-to-analog converter) merely laboratory curiosities or is the process practical and economically viable?

Panelists on an evening session at next month's upcoming Bipolar/BiCMOS Circuits and Technology Meeting (BCTM) in Minneapolis, Minn., (Oct. 10-11) hope to shed some light on those and other SiGe questions. The panel consists of eight experts in the high-speed/high-frequency IC transistor field. One expert, Dr. Bernard Meyerson of IBM, developed the ultra-high-vacuum molecular-beam epitaxy (UHV-MBE) technology that IBM uses to make SiGe ICs.

The panel has agreed to attack the following questions:

- What types of circuits lend themselves to SiGe HBTs?
- What types of systems lend themselves to SiGe HBTs?
- Will SiGe HBTs replace GaAs MESFETs? How about GaAs HBTs?
- Will silicon BJTs replace SiGe HBTs?
- Will deep-submicron MOSFETs ultimately replace Si BJTs and even SiGe HBTs?
- Just how far along is the commercialization effort of SiGe?

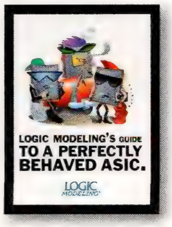
In addition to Meyerson, the panel consists of Dr. F. Chang (Rockwell International), Dr. John Cressler (Auburn University), Dr. K. Elliot (Hughes Aircraft), Dr. Christian Kerramec (Analog Devices), Dr. A. Khadibzadeh (Texas Instruments), Dr. A. Oki (TRW), and Dr. S.J. Prasad (Maxim Integrated Products).

Over the BCTM's two-day run, attendees will have access to over 65 papers. Analog ICs are the topic of 13 papers, a dozen more cover digital ICs, and the remainder represent an eclectic mix covering advanced bipolar and biCMOS processes as well as IC-device simulation and modeling.

Those interested in fast, wide-band transistor and IC technologies will find that the BCTM has much to offer. For example, Tuesday morning after the panel session, a group of papers will kick off with a 50-minute invited tutorial prepared by a joint Analog Devices-IBM team that includes Kerramec and Meyerson. Entitled "SiGe HBTs reach the microwave and millimeter-wave frontier," the paper will cover the communications, computer, and automotive applications that need the frequencies—ranging from RF to millimeter waves—which are

DO YOUR ASICs HAVE BEHAVIOR PROBLEMS?

You know the story. You raise your ASICs to behave perfectly. Then, as soon as they're turned loose with the rest of the system, they forget everything you told them. Be sure your ASICs operate just the way you designed them to, even on their first trip to the board, with simulation models from Logic Modeling.



LOGIC MODELING'S GUIDE TO A PERFECTLY BEHAVED ASIC.

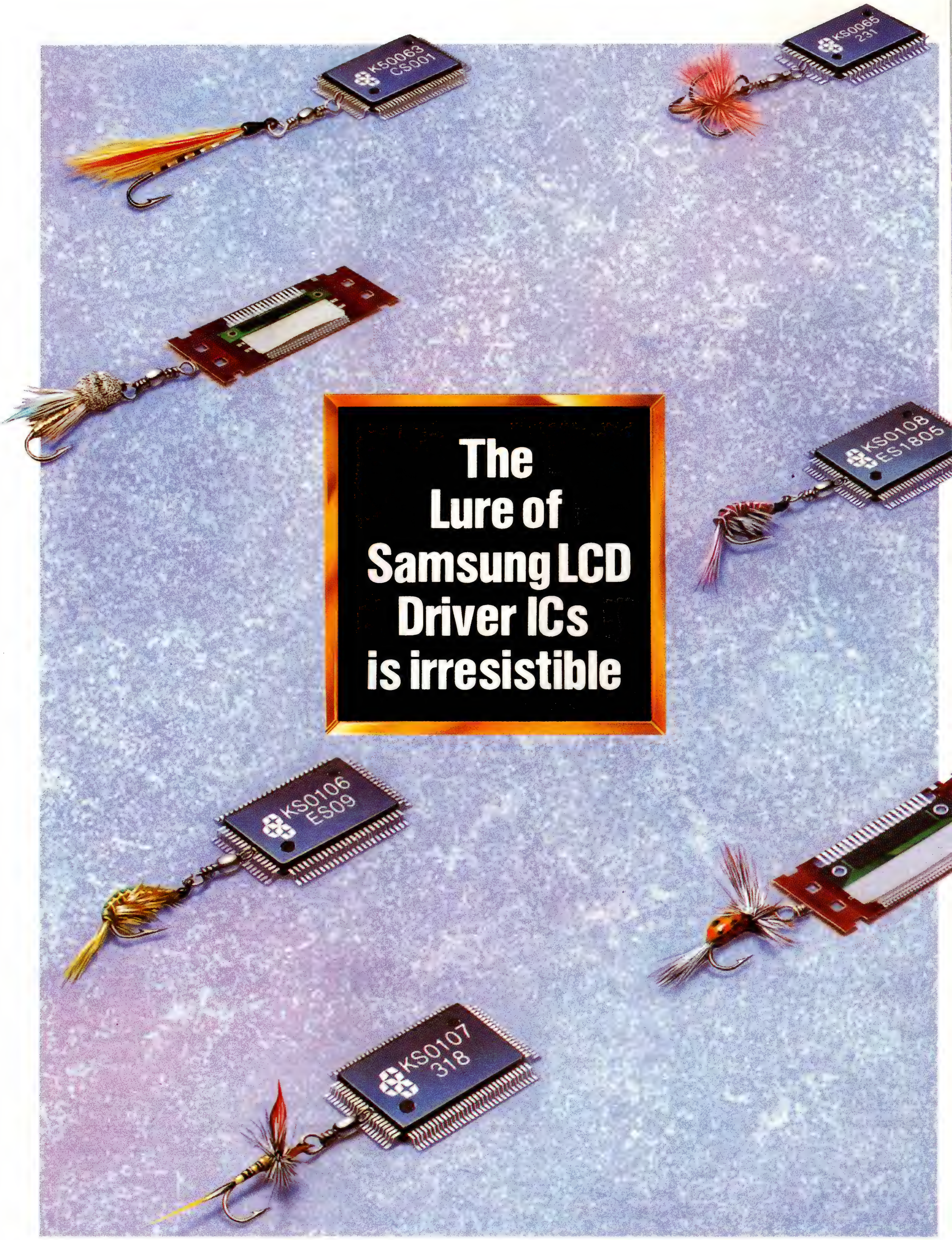
LOGIC MODELING

Logic Modeling's 12,000+ software and hardware models let you simulate your ASICs in the board or system — before you fabricate. No waiting for prototypes. No revisions. And the models are incredibly accurate because each is built using the actual chip or detailed design information from the semiconductor manufacturer. Plus, it doesn't matter which EDA vendor's tools you use; Logic Modeling works with every major simulator.

Ensure your ASICs are on their best behavior — no matter where they hang out. Use the most accurate simulation models: Logic Modeling. Get perfectly behaving ASICs. Even the first time around. This free booklet will tell you how. Call: Asia/Pacific: 82-2-538-3644. Europe: 44-1734-490004. Ask for Dept. LD1.

LOGIC
MODELING®

© 1994 Synopsys Inc. All rights reserved. Logic Modeling, the Logic Modeling logo and SmartModel are registered trademarks and LM-family and SourceModel are trademarks of Synopsys, Inc.


The Lure of Samsung LCD Driver ICs is irresistible
K50063 CSD01
KS0065 231
KS0108 ES1805
KS0106 ES09
KS0107 318

Experience the satisfactions that only comes from Samsung LCD driver ICs, including TN, STN, and TFT.

Samsung's outstanding LCD display technology ensures incredibly clear graphic data displays. Whether it's static, character or graphic panel drivers for thin film transitors that reproduce stunningly nature colors, Samsung is the videophiles' choice.

From the world leader in the field of DRAMs, Samsung offers a wide range of LCD driver ICs packing options that incorporate the customized fonts customers demand, competitive pricing, and QFP, slim-TAB designs.

Innovative LCD display technologies and premium quality products designed to ensure maximum customer satisfaction-Samsung LCD drivers ICs, the experts' choice.

SAMSUNG

SAMSUNG LCD IC LIST

Type	Device	Function	Package	V (logic)	V (lcd)	Vlcd (Hz)	SMPL
Static	KS0035	1/1 Duty 53seg 1/2 Duty 104seg	64QFP	3/6.5	3-Vdd	Fosc=48K	NOW
Character	KS0063	80seg DR	100QFP	5	11		NOW
	KS0076	16C/40S CNTR & DR	80QFP	3/5	5		NOW
	KS0068	16C/60S CNTR & DR	100QFP	5	10		NOW
	KS0070	16C/80S CNTR & DR	128QFP	3/5	10		NOW
	KS0071	32C/60S CNTR & DR	128QFP	3/5	13.5		94.4Q
Graphic with RAM	KS0107	64com DR	100QFP	5	17	600K	NOW
	KS0108	64seg DR	100QFP	5	17	1.0M	NOW
Graphic	KS0083	80com/seg	100QFP	–5	28	3.3M	NOW
	KS0084	80com/seg Mirror	100QFP	–5	28	3.3M	94.2Q
	KS0786	80seg DR	98STAB	3/5	33	6.5/8M	94.4Q
	KS0787	160seg DR	191STAB	3/5	37	6.5/8M	94.4Q
	KS0788	160com/seg DR	197STAB	3/5	40	8/12M	94.4Q
	KS0789	100com DR	120STAB	3/5	38	1M	94.4Q
TFT for TV	KS0601	120gate	135STAB	5	30	50K	NOW
	KS0602	120source	141STAB	5	18	10M	NOW
	KS0604	Controller (for TV)	32SDIP	5	5	8M	94.3Q

TECHNOLOGY
THAT WORKS
FOR LIFE

Certified ISO 9001
REGISTERED FIRM
NATIONAL ACCREDITATION OF CERTIFICATION BODIES
Certificate NO FM24653

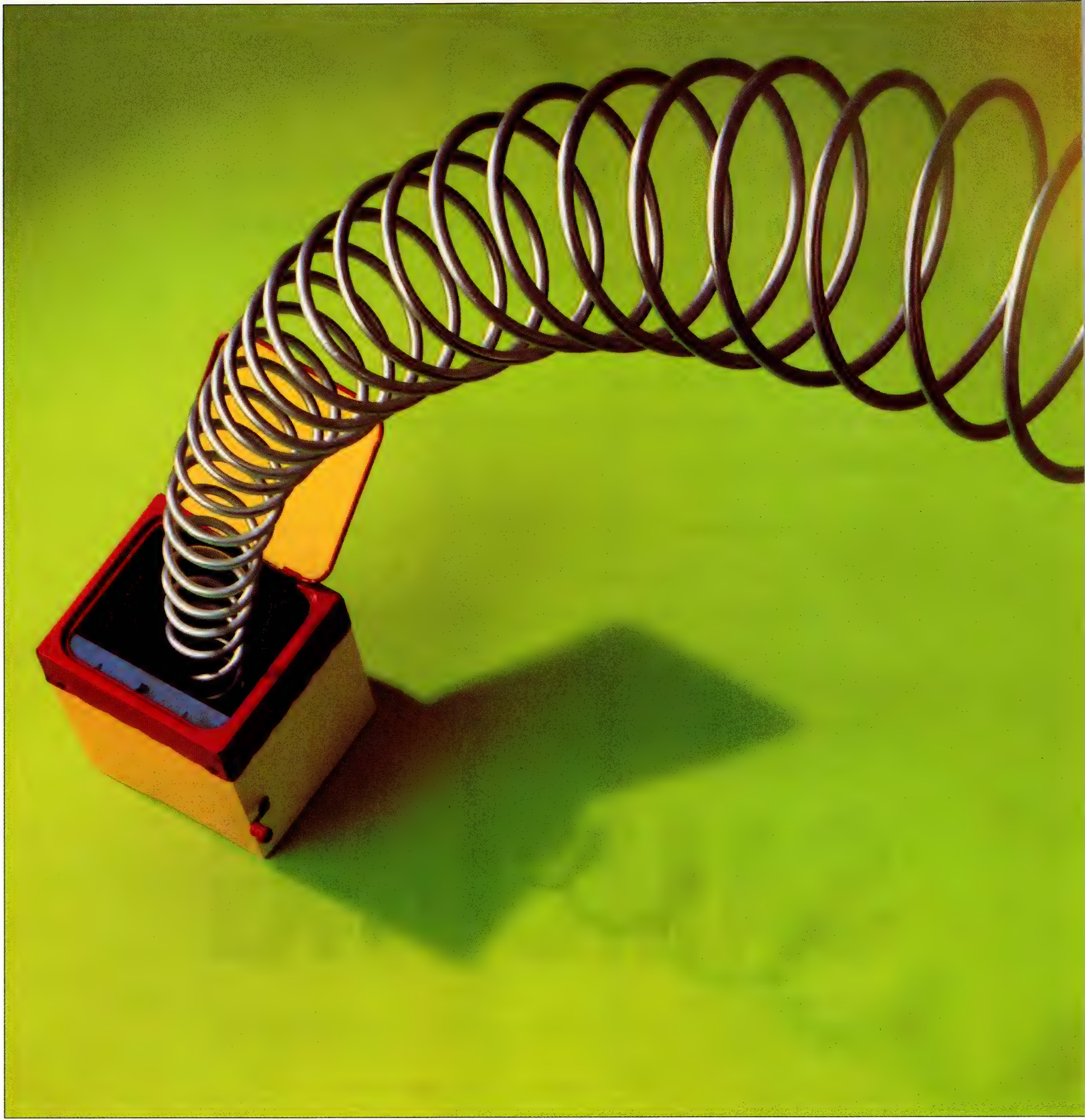
■ **SEMICONDUCTOR BUSINESS**

SALES & MARKETING DIV.(SEOUL, KOREA): TEL: (02) 259-1114 FAX: (02) 259-2468
SAMSUNG SEMICONDUCTOR INC.(USA, SANJOSE):
TEL: (408) 954-7000 FAX: (408) 954-7873
HONGKONG BRANCH: TEL: 8626900 FAX: 8661343
TAIWAN BRANCH(TAIPEI): TEL: (2) 757-7292 FAX: (2) 757-7311

SAMSUNG ELECTRONICS JAPAN CO., LTD.(TOKYO):
TEL. (03) 5641-9850 FAX. (03) 5641-9851
SAMSUNG SEMICONDUCTOR EUROPE GMBH (FRANKFURT):
TEL. 0049-6196-90090 FAX: 0049-6196-900989
SINGAPORE PTE LTD.,: TEL: 535-2808 FAX: 227-2792

READER SERVICE 129

SAMSUNG
ELECTRONICS



©1994 Xilinx, Inc., 2100 Logic Drive, San Jose, CA 95124. Europe, 44 (932) 349401; Japan, 81 (3) 297-9191; Asia, 852 (3) 721-0900. Xilinx is a registered trademark, Universal Interconnect Matrix is a trademark, and The Programmable Logic Company is a service mark of Xilinx, Inc.

MOST EPLDS ARE VERY PREDICTABLE. SOONER OR LATER THEY'RE GOING TO CAUSE PROBLEMS.

There are times when you want to be surprised. Say, on your birthday, or Christmas.

Then there are times when a surprise is far less welcome. Like when you have to change your pinouts to accommodate last minute design changes.

That's when you'll appreciate the predictability of our 100% routable, 100% utilizable Xilinx XC7000 EPLDs.

All other trademarks or registered trademarks are the property of their respective holders.

The only surprises they offer are pleasant ones.

You see, only Xilinx EPLDs use our patented Universal Interconnect Matrix.™ The UIM not only guarantees 100% routing, it also lets you make design changes without changing the pinouts. They're also unexpectedly quick—just 5ns, pin-to-pin, to be exact.

Integrating your design is almost as fast.

Since our EPLDs look like PALs, you already know the design methodology.

Our software won't present any shocks to your system, either.

There's built-in logic optimization, a PAL conversion utility and support for both PAL compiler and schematic-based design entry.

Yet, in spite of all they offer, they're priced so low, you'll jump at the chance to use them.

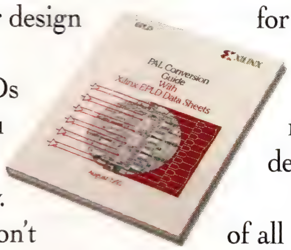
To get a copy of our PAL Conversion Guide packed with more info, call us at 800-231-3386, or talk to your Xilinx representative. Because when you get right down to it, nobody makes better EPLDs than Xilinx.

Which really shouldn't surprise anyone.

XILINX®

The Programmable
Logic Company.℠

READER SERVICE 178



attainable only with the high-performance, low-cost components provided by the silicon semiconductor industry. The tutorial will address SiGe HBT technology performance at microwave and millimeter-wave frequencies, as well as its applicability to wireless receivers and microwave sensors.

The same session carries a second SiGe paper by a team from NEC. It describes SiGe ICs that were developed for a 20-Gbit/s optical transmitter using a self-aligned SiGe-base bipolar transistor built on a bonded-wafer substrate. These ICs include a selector, multiplier, and D-type flip-flop. The session's third paper describes a low-noise, high-gain silicon-bipolar transimpedance amplifier for 10-Gbit/s optical-fiber links created by a team at Ruhr University, Bochum, Germany.

Some of the other subjects in the session include analog, digital, modeling, and device/process discussions. On the analog front, notable technical papers include:

- Paper 1.1 from Analog Devices. Its subject is a 14-bit, 2.5-MHz, pipelined and subranging ADC with on-chip EPROM that needs less than 500 mW of power. In addition to laser-wafer trimming, the on-chip "write-once" EPROM calibrates interstage gain errors at the package sorting stage. The ADC delivers an integral nonlinearity (INL) as low as ±1.5 least-significant bit (LSB) and a differential nonlinearity (DNL) as low as –0.6, +0.8 LSB. The chip is fabricated on a 2-µm/10-V CMOS process.
- Paper 1.2 from National Semiconductor. This presentation discusses a pair of fast, low-power, voltage-feedback op amps built on a 40-V complementary-bipolar process. One chip sports a bandwidth of 110 MHz and slews at a rate of 2000 V/µs, yet it draws less than 2.5 mA of current from ±15-V power-supply rails. The other chip needs 6.5 mA of current, but it slews even faster and its bandwidth runs 200 MHz.

WANT TO GO?

For more information on the BCTM, including a copy of the advance program, call (612) 934-5082 (there's a 24-hour voice-mail service). You can also fax your request to (612) 934-6741, or mail it to Janice Jopke, Conference Coordination services, 6611 Countryside Dr., Eden Prairie, MN 55346. Her e-mail address is jjopke@aol.com.

- Paper 1.4 from Motorola Semiconductor and the Allen-Bradley Co. This "smart" motor protector is quite a different device. The micropower, motor-powered switch-mode IC protects large inductive motors drawing from 9 to 1200 A of current.
- Paper 5.1 from NEC. This invited tutorial covers design techniques for analog-biCMOS ICs. It covers the design of a biCMOS op amp as a basic analog-building-block circuit.
- Paper 5.2 from Siemens. Discussed is a 1-µm biCMOS adaptive, analog notch filter for applications in analog telephone subscriber lines. The IC takes advantage of its accurate switched-capacitor filters, its low-offset comparators, and analog multipliers.
- Paper 11.2 also from Siemens. This paper talks about a 2.7-V, 800-to-2100-MHz transceiver chip set for mobile radio applications. The transmitter and receiver chips are built on a 25-GHz bipolar process. The chip's circuits include a direct-conversion quadrature modulator, IF and RF synthesizers, as well as a programmable 80-dB IF amplifier.

On the digital side, notable papers include:

- Paper 2.1 from Intel. This invited tutorial discusses current techniques for high fan-in circuits using CMOS, biCMOS, and ECL circuits. It concludes with a description of a new biCMOS IC that can handle fan-ins of greater than 32 in a single stage.
- Paper 2.4 from Cypress Semiconductor. It discusses a 4.5-ns 22V10-type PAL built on a 0.5-µm biCMOS process. The use of ECL-level swings provides the high speed.
- Paper 6.2 from Sun Microsystems. The subject of this paper is a subnanosecond 64-kbit biCMOS SRAM. This 2-kword-by-32-bit device features a very fast access time of just 900 ps.
- Paper 6.4 from Texas Instruments. Its subject focuses on a family of voltage-scalable, gigahertz-type, biCMOS interface circuits, which are basic building blocks for communication ICs running at data rates above 2.5 Gbits/s. The devices can operate with nominal power-supply voltages below 2.5 V.
- Paper 7.3 from Mitsubishi. The paper discusses an active-pull-down ECL circuit that adjusts its pull-down capability to the load capacitance. As a result, it achieves a power dissipation in a class with that of CMOS devices.

Key papers concerning modeling include:

- Paper 3.4 from Toshiba. The subject of this paper is a modeling technique for scaling down bipolar-silicon analog transistors. The technique allows designers to model such parameters as power, noise figure, and power gain.
- Paper 8.1 from AT&T. The theme of this paper is chip-level electrothermal simulation of bipolar-junction-transistor (BJT) circuits. The paper goes into the accurate electrothermal modeling of both self and mutual heating of ICs. Thermal transmission-line models are used for coupled heating. Those models are implemented in a novel and very robust electrothermal simulator known as the SFRAME.

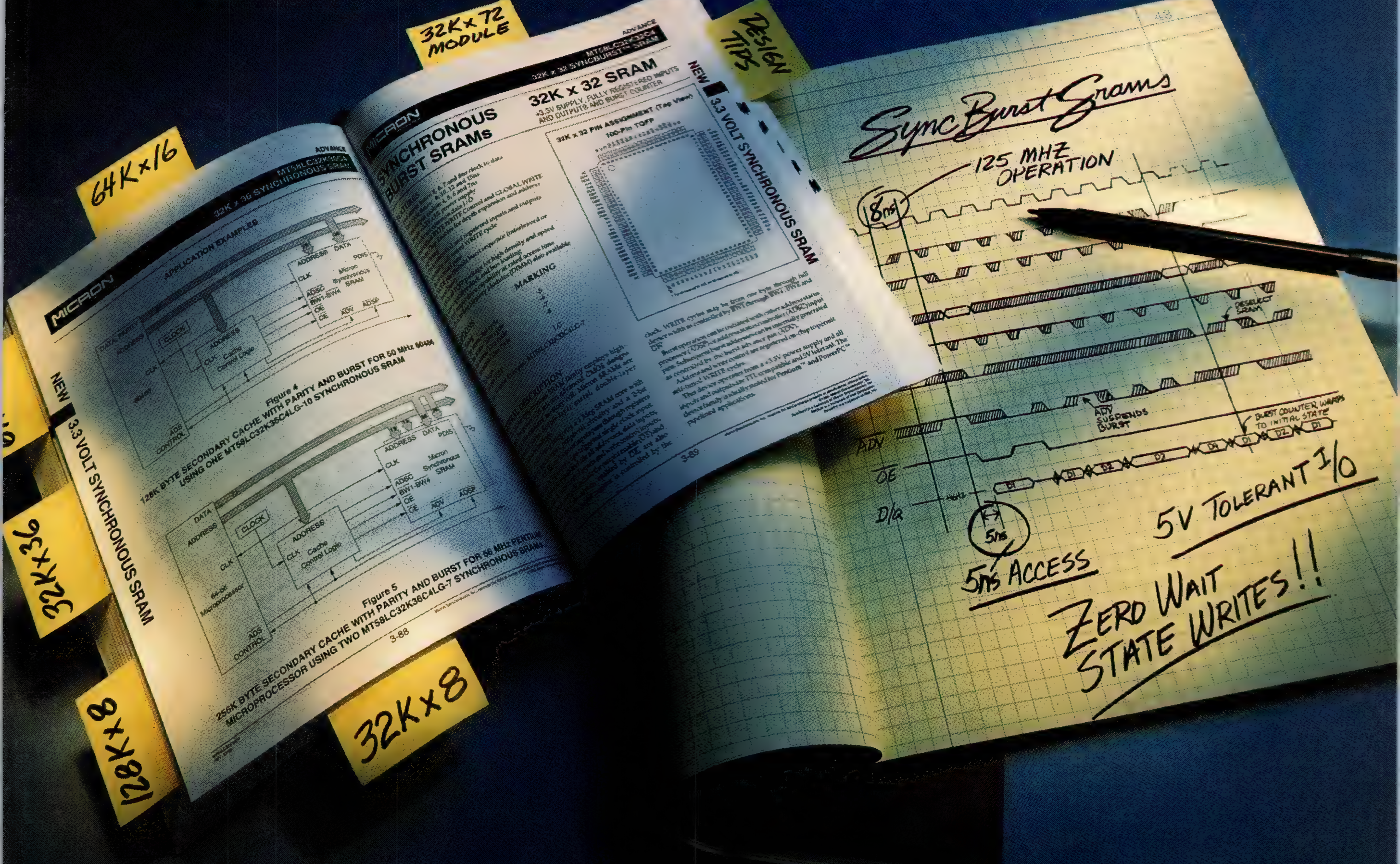
Finally, on the device/process front, two notable papers are:

- Paper 4.1 from Oki Semiconductor. This paper talks about a 40-GHz two-step epitaxial-base bipolar process. The process features very low junction capacitance.
- Paper 8.4 from the University of Wisconsin. This paper describes the BJT's effect in the switching dynamics of insulated-gate bipolar transistors (IBGTs) in resonant-converter type circuits. Both experimental and theoretical results are provided.

The BCTM's keynote address will be delivered by David Fullagar of Maxim Integrated Products, the designer of the venerable Fairchild µA741 op amp. He will talk about the glowing and growing future for bipolar ICs in both analog and digital applications, and the need for IC designers who can handle their "analog" speed and bandwidth requirements. He also will underscore the fact that high-speed digital-IC design still requires very solid analog skills.

FRANK GOODENOUGH

The broadest line of 3.3V SRAMs available.



Performance, selection and value. Imagine what you could do with that.

Imagine the possibilities. A full line of high-speed 3.3V SRAM solutions for cache systems, DSP applications, communications subsystems, disk drives — virtually any design you envision. And we deliver performance, selection and value today.

At .35µ we offer the fastest 3.3V SRAM CMOS process with 5v tolerant I/O in a wide array of high speed components, including our latest 32K x 32 SyncBurst™ SRAM family.

Call Micron for more product information. Because with our broad line of 3.3V SRAMs, there is no limit to your imagination.

Product Family	Density	Organization	Features	Fastest Access Time	Samp. Avail.	Prod. Avail.
SRAMs	1 Meg	x1,x4,x8,x16	Revolutionary and evolutionary pinout	15ns	Now	Now
	256K	x1,x4,x8	Evolutionary pinout	12ns	Now	Now
Synchronous SRAMs	1 Meg	x18,x32,x36	Interleave or linear burst	9ns	Now	Now
	1 Meg	x18,x32,x36	Interleave or linear burst, pipelined	4.5ns	Now	Now
SRAM Modules						
Async	256KB-4MB	x32	64-pin or 72-pin industry standard	15ns	Now	Now
Synchronous	256KB-512KB	x64,x72	Interleave or linear burst, pipelined or nonpipelined	4.5ns	Now	Now

Certified ISO 9001

MICRON

TECHNOLOGY That works for you.

Micron Europe Limited, Centennial Court, Easthampstead Road, Bracknell, Berkshire RG12 1JA, U.K. Tel: 44 1344 360055, Fax: 44 1344 869504
Micron Semiconductor (Deutschland) GmbH, Sternstrasse 20, D-85609 Aschheim, Germany Tel: 49 89 9030021, Fax: 49 89 9043114
Micron Semiconductor Asia Pacific Pte Ltd., 629 Aljunied Road #07-21, Cititech Industrial Bldg., Singapore 1438 Tel: 65 841 4066, Fax: 65 841 4166
Customer Comment Line: 01 208 368 3410, Customer Comment Fax: 01 208 368 3342

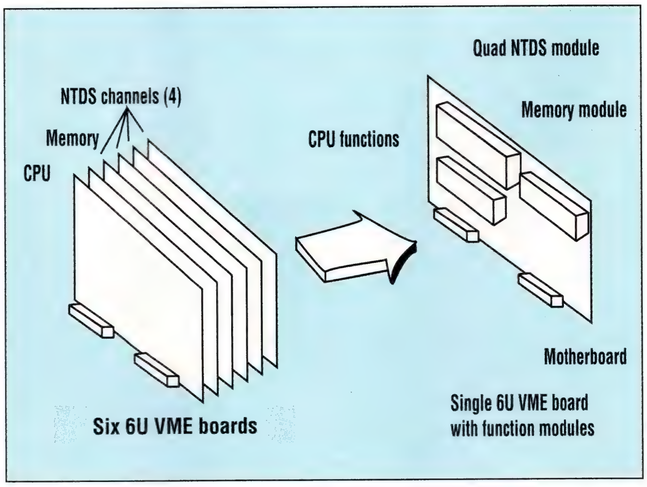
SyncBurst is a trademark of Micron Semiconductor, Inc. ©1994, Micron Semiconductor, Inc.

READER SERVICE 111

CERAMIC SUBSTRATES AND PLAS KEY TO LOW-COST AND DENSE FUNCTION MODULES

Until recently, the need to build low-cost systems and achieve swift time-to-delivery were felt more keenly in the commercial sector than in the military arena. Now budget cuts have changed that. As a result, not only is commercial, off-the-shelf (COTS) technology being pressed into service wherever possible, but faster turnaround of boards and systems is expected of Department of Defense suppliers as well.

Nonetheless, demand continues for systems that meet military specifications and those that are called on to meet near-mil-spec requirements. One such example involves VME boards that can work in all kinds of harsh environments: extremes of high and low temperatures, high altitudes, and locations rife with shock and vibration. That demand also spills into the avionics and medical-instrumentation fields, both of which must have highly reliable hardware and software.



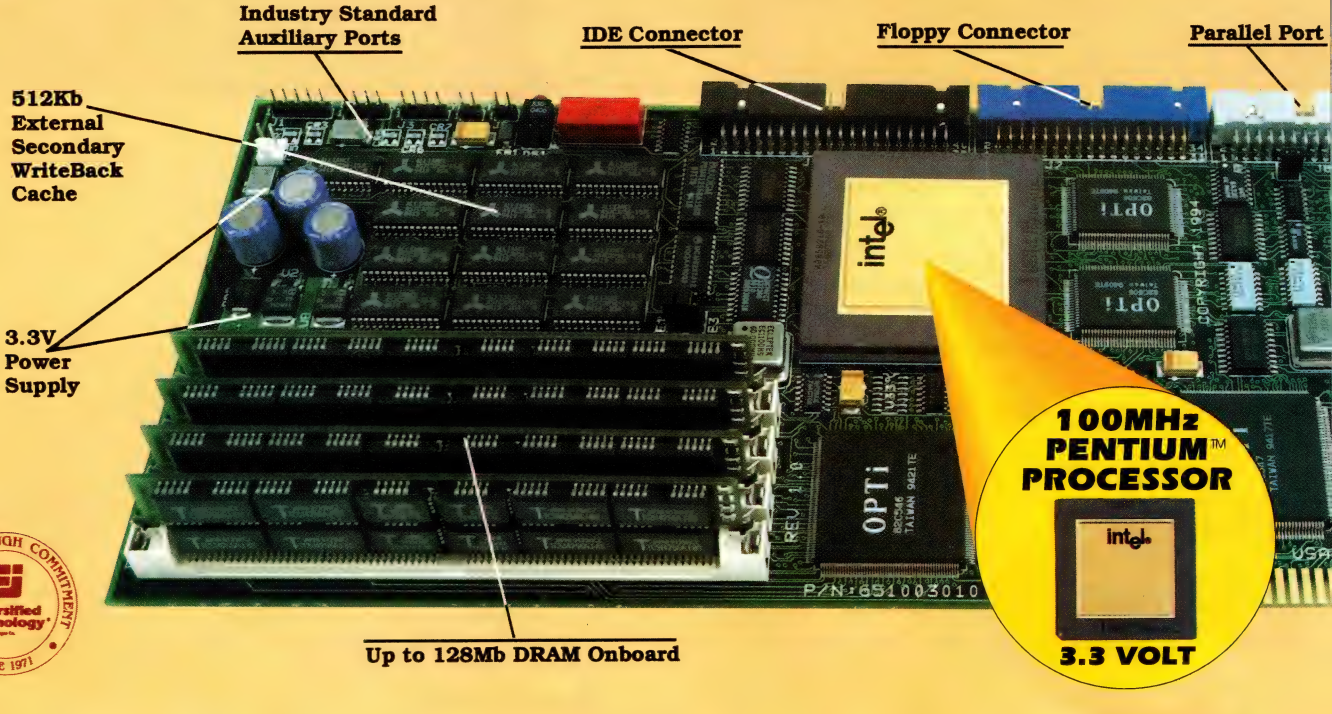
VisiCom Laboratories, San Diego, Calif., is meeting this challenge through the use of ceramic substrates. Combined with high-density programmable-logic arrays (PLAs), it provides the company with a highly modular approach that allows it to develop entire computer systems on one board. Moreover, these low-cost VME boards can be produced with a fast turnaround for military as well as near-mil-spec environments.

The expertise in ceramic-substrate technology comes from Microlithics Corp., Golden, Colo., a company recently acquired by VisiCom. VisiCom is a software house known primarily for writing operating systems and real-time applications, as well as for porting soft-

Fault Tolerant Offering
Next Page

100MHz PENTIUM™ PR

Passive Backplane Single Board Co


Industry Standard Auxiliary Ports
IDE Connector
Floppy Connector
Parallel Port
512Kb External Secondary WriteBack Cache
3.3V Power Supply
Up to 128Mb DRAM Onboard
100MHz PENTIUM™ PROCESSOR
3.3 VOLT

QUALITY THROUGH COMMITMENT
Diversified Technology
SINCE 1971

ware. Microlithics develops and produces Standard Electronic Modules (SEMs) for U.S. Navy programs, including the AN/UYK-44 embedded computer and the AN/SQQ-89 shipboard sonar system.

Ceramic substrates provide superior heat-transfer properties. Unlike epoxy-glass boards, ceramic substrates allow higher chip densities and higher power-dissipation levels on the modules.

Using the high-density PLAs, a basic gate-array module can serve a number of different tasks. The module, for example, can be programmed for a wide variety of functions, reducing inventory costs of special-purpose modules and thus cutting overall costs and lead times.

Basically, the idea is to reduce board count by using modules that were already tested and to meet various mil specs. For instance, a system that once consisted of six 6-by-9-in. VME boards containing memory, the CPU, and four Naval Tactical Data System (NTDS) channels—NTDS being the military equivalent of the Small Computer Systems Interface (SCSI)—can readily be trimmed to one board. The modules for CPU functions, memory, and four NTDS channels then go on the board *(see the figure)*.

"We wanted to be able to very rapidly repackage existing COTS designs into a partial mil environment. We don't want to redesign the board from scratch each time," says Cliff Cooke, VisiCom's president. He says that a "tailored COTS environment" may trail commercial board releases by three to four months, but will not lag three to four years as they once have.

For its part, VisiCom buys off-the-shelf parts whenever possible, using processor boards developed by Hewlett-Packard and Motorola, for example. Though the company repackages and sells boards, it sees itself as a subsystem supplier to the likes of Hughes and Unisys, whether the systems consist of a single card or multiple cards, Cooke says.

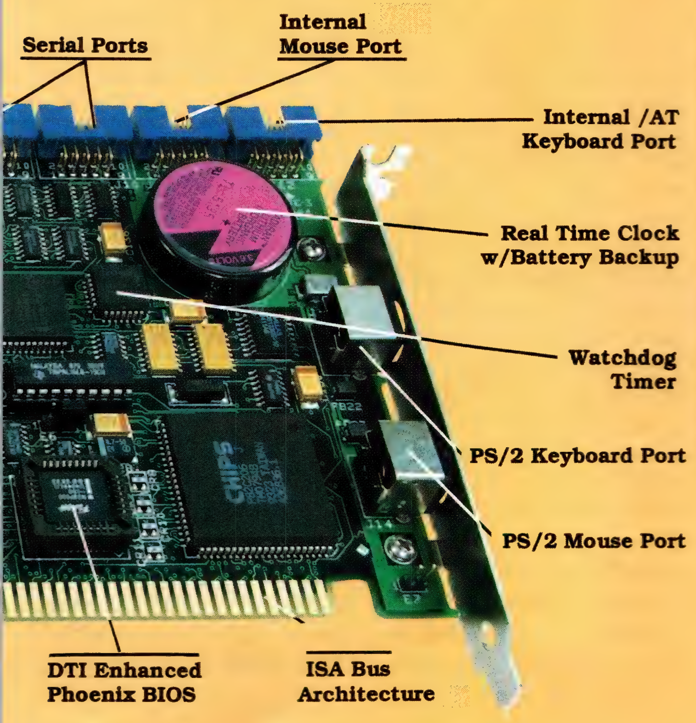
For more information, contact VisiCom at (619) 457-2111.

SHERRIE VAN TYLE

VXIPLUG&PLAY TO RESCUE TEST-SYSTEM INTEGRATORS

Help has arrived for designers who want to take advantage of the VXIbus for their test and measurement tasks but have been deterred by the complexity of VXIbus system integration. A wide range of easier-to-integrate products soon will become available with the VXIplug&play Systems Alliance's approval of nine specifications, mostly aimed at simplifying the software side of VXIbus integration.

Another key factor is



ESSOR

uter Architecture

3.3 VOLT LOW HEAT

SPECIFICATIONS	CAT3010 Pentium™ Processor	CAT3001 Pentium™ Processor	CAT1070 i486™ Processor	CAT1012 i486™ Processor
100MHz PENTIUM™ 3.3 VOLT	✓			
60/66MHz PENTIUM™ 5 VOLT		✓		
50MHz 486DX & 50/66MHz 486DX2			✓	✓
33MHz 486DX/SX			✓	✓
VGA True Color w/BitBlt			✓	
Up to 512Kb PROM/FLASH Disk			✓	
16Kb Internal Pipelined Cache	✓	✓		
512Kb WriteBack 2nd Cache	✓	✓		
64Kb/256Kb WriteBack 2nd Cache			✓	✓
8Kb Internal Cache			✓	✓
Up to 128Mb DRAM Onboard	✓	✓		
Up to 64Mb DRAM Onboard			✓	✓
2 Serial Ports / 1 Parallel Port	✓	✓	✓	✓
IDE/Floppy Interface	✓	✓	✓	✓
PS/2 Mouse Support	✓	✓	✓	✓
/AT-PS/2 Keyboard Support	✓	✓	✓	✓
Manufactured In-House(USA)	✓	✓	✓	✓
Powermeter 1.2 MIPS 100MHz Pentium	70.1			
Powermeter 1.2 MIPS 66MHz Pentium		44.8		
Powermeter 1.2 MIPS-60MHz Pentium		40.2		
Powermeter 1.2 MIPS-66MHz 486 DX2			28.8	26.6

Diversified Technology®
An Ergon Co.

Call us toll free for orders and information.

1-800-443-2667

U.S.A. - (601) 856-4121 Fax (601) 856-2888
Outside U.S.A. - (201) 891-8718/Fax (201) 891-9629

Product names are trademarks or registered trademarks of their respective companies.
386, 486 & PENTIUM are trademarks of Intel Corp.

READER SERVICE 90

Hewlett-Packard's entrance into the Alliance, which now has 25 members. HP signed on to the effort after the Alliance accepted several changes to its charter. The company felt the changes were needed to ensure that the instrument driver technology created by the Alliance allows test-system developers a choice of instrument control software, rather than being limited to products from one vendor.

Although interoperability of modules from different vendors was a guiding principle of the VXIbus Consortium when it wrote the original specification, software issues never were addressed. As a result, VXI-compliant modules from multiple vendors can be integrated into a system, but differences in the software drivers create problems. The VXIplug&play Alliance was founded last September to simplify the creation of multivendor systems by implementing system-level standards and practices beyond the baseline specifications produced by the VXIbus Consortium.

By approving the nine specifications, the Alliance says that everything is in place for vendors to design VXIplug&play-compatible modules. The documents include:

- The Charter Document (VPP-1)
- The System Frameworks Specification (VPP-2)
- The Instrument Driver Architecture and Design Specification (VPP-3.1)
- The Instrument Driver Developers Specification (VPP-3.2)
- The Virtual Instrument Software Architecture (VISA) Transition Library Specification (VPP-3.3)
- The VISA Specification (VPP-4.1)
- VXI The Component Knowledge Base Specification (VPP-5)
- The Installation and Packaging Specification (VPP-6)
- The Soft Front Panel Specification (VPP-7)

Earlier this year, the Alliance asked HP to list what changes were required in the charter document in order for the company to join. At its July 15 meeting, 15 such changes were proposed. After discussion on each, members approved eight changes and rejected five (all of which related to the list of core technologies to be addressed). Two changes regarding future direction and technology were withdrawn by HP. The only change to the core technologies reflected in the specifications was the addition of HP-UX to the list of operating systems.

HP said that the Alliance's guidelines—particularly those relating to interoperability, ease of use, and system support—were consistent with the company's direction and focus as a test-system vendor. As a result, HP worked closely with members to resolve the issues that initially precluded the company from joining.

The changes "will allow us all to work toward truly open, standards-based, multivendor solutions," according to George Sparks, general manager of HP's VXI Systems Div. in Loveland, Colo. "We requested that the Alliance eliminate vendor-specific products and instead focus on technologies, including a standard instrument driver and I/O subsystem. This will allow everyone to participate and still support their existing customer base" he says.

The Alliance's users group, which is open to any user or potential user of VXI technology, had grown to 145 members as of late July. Membership is free. Also, VXI system developers and end-users can exchange comments, questions, and ideas through a new technical forum on Internet. The Alliance plans to use the VXIplug&play forum to exchange information during beta testing of the first VXIplug&play products. In addition, users can seek answers to technical questions and solutions to problems.

To subscribe to the forum, send an electronic message with your name and Internet address to: vxipnp-subscribe@natinst.com. Messages can then be posted at: VXIpnp@natinst.com.

JOHN NOVELLINO

SYMBOLIC LOGIC REPRESENTATION SPEEDS DESIGN VERIFICATION

A design - verification tool conceived by Chrysalis Symbolic Design Inc., Andover, Mass., significantly speeds ASIC and IC design by using a symbolic approach to logic representation. Unlike traditional logic simulation that relies on comparing responses to stimuli, the symbolic-based tool evaluates the logic functions of two circuit descriptions to prove whether or not they're equivalent. It can verify individual modules or an entire chip.

Symbolic-based verification also has advantages over formal-verification approaches that rely on binary decision diagrams (BDDs). These approaches are limited to circuits with a few thousand gates. The symbolic-based tool, however, is computationally fast and exhibits performance that scales smoothly with circuit size.

Called Design Verifyer, the tool expresses a design's logic using signal names as variables in equations that show the derivation of signal's value from any input combination. More specifically, Design Verifyer relies on a set of algorithms that can quickly prove the equivalence or inequivalence of two seemingly different cones of logic that allegedly represent the same logic function. A cone is a set of logic elements which combine to give a particular node in the circuit its value. To handle radically different deep sequential circuits and combinational circuit versions, Design Verifyer automatically partitions circuits into comparable chunks independent of any partitioning used in the design.

This symbolic approach raises the level of abstraction at which engineers look at and verify a circuit. Brian Doyle, the company's founder and president, says that engineers find the symbolic approach more natural than dealing with the vast files of ones and zeros associated with logic simulation.

Design Verifyer isn't meant to replace logic simulation, but rather to eliminate the need to run simulation every time the design is revised. The tool checks modified RTL descriptions against the originals, gate-level implementations against RTL descriptions, modified gate-level descriptions against previous ver-

INCREASED COOLING

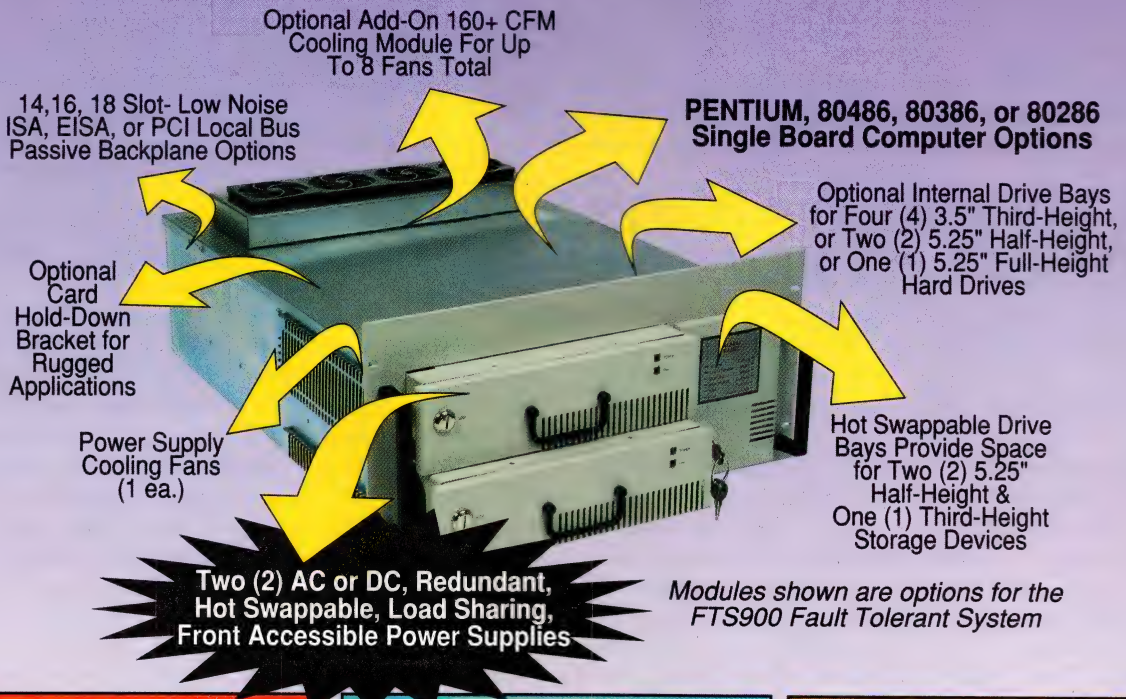
NOW AVAILABLE

IBM COMPATIBLE INDUSTRIAL FAULT TOLERANT RACKMOUNT COMPUTER

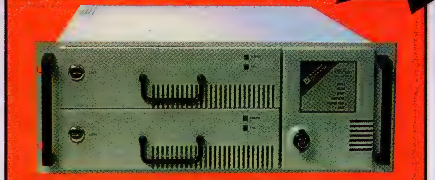
Choose From DTI's Selection Of PENTIUM ™, 80486 ™, 80386 ™ or 80286 Single Board Computers. Bus Architectures Available Include ISA, EISA & PCI Local Bus

With Diversified Technology's 19" Rackmountable Computers, you can custom configure a complete industrial system that is tailored for your application. "*Pack*" it with modules chosen from DTI's selection of passive backplanes, CPU cards, hard & floppy drives, as well as power supplies. Combine the "*packed*" rackmount with DTI's rackmountable components and "*Stack*" it to create a complete Industrial Computer Solution. DTI's selection of rackmount components includes: monitor enclosures, printer drawers, video/keyboard switches, keyboards w/drawer and various sizes of slides. Each DTI Rackmount Computer is UL & FCC Recognized and comes with a full one year warranty. Let DTI help you to "Pack & Stack" quickly and easily. Call for more information on DTI's rackmount family.

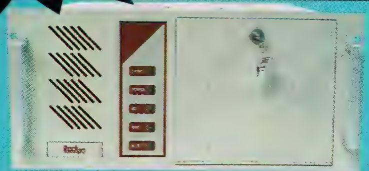
REDUNDANT - HOT SWAPPABLE POWER SUPPLIES


Optional Add-On 160+ CFM Cooling Module For Up To 8 Fans Total
14,16, 18 Slot- Low Noise ISA, EISA, or PCI Local Bus Passive Backplane Options
PENTIUM, 80486, 80386, or 80286 Single Board Computer Options
Optional Internal Drive Bays for Four (4) 3.5" Third-Height, or Two (2) 5.25" Half-Height, or One (1) 5.25" Full-Height Hard Drives
Optional Card Hold-Down Bracket for Rugged Applications
Power Supply Cooling Fans (1 ea.)
Hot Swappable Drive Bays Provide Space for Two (2) 5.25" Half-Height & One (1) Third-Height Storage Devices
Two (2) AC or DC, Redundant, Hot Swappable, Load Sharing, Front Accessible Power Supplies

Modules shown are options for the FTS900 Fault Tolerant System

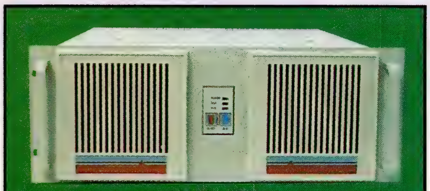


14, 16 or 18 Slot - ISA, EISA or PCI Local Bus
Fault Tolerant FTS900



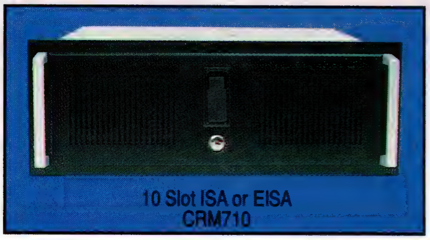
10,14,16 Slot - ISA, EISA or PCI Local Bus
CRM816

14 Slot ISA, EISA or PCI Local Bus w/Built-In Monitor
CRM814



20 Slot ISA
CRM720

14 Slot ISA, EISA or PCI Local Bus
CRM716



10 Slot ISA or EISA
CRM710

Diversified Technology®
An Ergon Co.

Call us toll free for orders and information
U.S.A. - (601) 856-4121 Fax (601) 856-2888
Outside U.S.A. - (201) 891-8718/Fax (201) 891-9629
1-800-443-2667

Product names are trademarks or registered trademarks of their respective companies. 80386, 80486 & Pentium are trademarks of Intel Corp. The Intel Inside Logo is a trademark of Intel Corporation.

READER SERVICE 91

sions, and the equivalence or inequivalence of models in Verilog and VHDL.

Comparison requires no user intervention, such as identification of storage elements or name mapping. If the tool finds a difference between two circuit descriptions, it isolates the problem and displays the logic expressions that don't agree. This helps engineers because instead of trying to track a bug from its effect, they see the actual cause of the difference immediately. In addition, unlike simulators that rely on user-provided input patterns to exercise logic, the Chrysalis approach checks all logic.

Users can constrain symbolic-based verification in several ways. First, they can instruct Design Verifyer to compare only the logic contained in a particular module, or ignore the logic contained in a particular set of modules. Moreover, they can set input values that condition the verification so that Design Verifyer ignores parts of the logic. This suppresses spurious miscompares when the circuits are known to be different, such as when one circuit contains test logic and the other doesn't.

Chrysalis also has two other tools based on the symbolic-representation technology. Insight/sm helps users analyze state machines in control logic. It automatically extracts a state-machine definition and displays a state-transition table that reveals every reachable state, all the transitions, deadlock states, and transitions that don't depend on the present state. The second tool, Insight/dp, aids in analyzing datapath logic. It helps users understand datapaths quickly because they can see how the design operates on data for each combination of control inputs.

All of the Chrysalis tools run on Unix workstations. For more information about the tools, call (508) 475-7700.

LISA MALINIAK

VITA AND MMG JOIN FORCES TO PROMOTE PCI MEZZANINE CARD

Two rival groups promoting competitive bus architectures, the Multibus and the VMEbus, are now joining forces thanks to a new industry-standard mezzanine connection. Both the Multibus Manufacturers Group (MMG), Aloha, Ore., and the VFEA International Trade Association (VITA), Scottsdale, Ariz., will endorse a mezzanine architecture. The novel architecture is based on the PCI specification.

The new standard mezzanine connection is known as the PCI Mezzanine Connector (PMC). It will fit on compliant VMEbus, Futurebus+, and Multibus I and II baseboards. As a result, the same PMC module will operate across all four platforms. Mezzanine vendors then can concentrate on the modules' particular application, rather than spend valuable design time developing interfaces for the different environments they operate in .

Among the several companies supporting the PMC specification are Concurrent Technologies, Digital Equipment, Force Computers, Heurikon, Intel, Interphase, Mercury Computers, Molex, Motorola Semiconductor, Newbridge Microsystems, and Schroff. A few PMC-ready host-computer boards already have been introduced, including those by Heurikon and Motorola on the VME side, and by Intel on the Multibus II side.

The PMC is a subset of the PCI specification that offers a lower physical profile than the standard PCI modules, which are gaining prominence in the PC industry. In the PMC standard, the PCI bus acts as a local connection between the processor-memory array and the system peripheral controllers, as is the case with the PC. The PMC, defined under IEEE specification P1386.1, uses layers that are electrically and logically similar to PCI, but physically uses a different connector.

A VMEbus board with a PMC module still fits the VMEbus form factor in one slot. The PMC's high bandwidth offers a transfer rate of 132 Mbytes/s in a 32-bit mode as well 264 Mbytes/s using 64 bits—the same as a PCI peripheral. On most baseboards, the PMC module will connect either through the baseboard's front panel or through a rear connector.

The first PMC modules will be used for graphics, the Fiber Distributed Data Interface (FDDI), asynchronous-transfer-mode (ATM) communications, data acquisition, and other high-performance I/O functions.

The PCI specification is controlled by the PCI Special Interest Group (SIG). The PCI SIG is most concerned with the PCI mechanical and electrical considerations of the PMC. The group supports the PCI specification as long as it complies with the PCI-specified logical and electrical layers. Because the PMC connection specification doesn't conform to the PCI physical specification, the SIG won't endorse that connection scheme.

Pentek Technologies, Norwood, N.J., is one company that will offer PMC modules. The PMC modules will probably be made available in the first half of next year.

Rodger Hosking, a vice president at Pentek, says, "At this point, we're in the information-gathering and strategizing mode to see how we can take advantage of this technology. We see that the industry's major players are moving in that direction."

Pentek already produces mezzanine modules for other standard buses, so the core technology already exists. This is particularly the case in the high-performance data-acquisition and DSP-function areas.

Hosking says that one of the biggest concerns for the PMC is that designers won't be able to squeeze enough components on the module because of its limited board space. "But," he offers, "everybody is in the same situation. Some of the newer packaging techniques, such as surface mounting, chip-on-board, and multichip modules, will help us get there. But we also wish there was more room."

For more information on the PMC specification, call Len Schulwitz, executive director of the MMG, at (503) 696-7155, or Mike Humphrey, executive director of VITA, at (602) 951-8866.

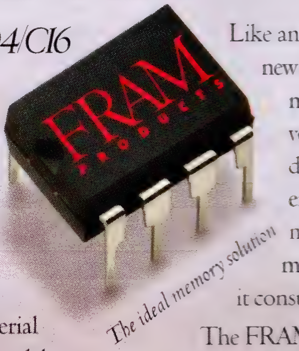
RICHARD NASS

Does your serial EEPROM fail the fast writing test?

Let Ramtron's FM24C04/C16 take the final exam.

With 10 millisecond write-time delays, serial EEPROMs are bound to fail...even in moderate tests of speed.

But there's hope. Because Ramtron's new 24C04/C16 serial FRAM products have no write delay.



Like an EEPROM, our new serial FRAM memory is non-volatile. But it delivers greater endurance, with nearly 10 billion more writes. And, it consumes less power.

The FRAM family of advanced memory products includes 4K byte-wide as well as 4K and 16K serial configurations...at prices that are less than you'd expect. They're perfect for consumer electronic products, business machines, communications equipment, test instruments, industrial controls, medical equipment and more.

Discover the facts for yourself. Call 1-800-545-FRAM, Ext. AF03 today for our "Ideal Memory Kit" and put our FRAM products to the test.

24C04/C16	Write Time	Active Power	Read/Write Endurance
FRAM	no delay	0.5 mW	10 billion cycles
EEPROM	10 ms	10.0 mW	100,000 cycles

RAMTRON

1850 Ramtron Drive, Colorado Springs, CO 80921. (719) 481-7012. ©1994 Ramtron International Corporation. RAM-147-01-94-ED

READER SERVICE 128

Kepco power supplies talk...

...and listen...and stabilize voltage and current with 12 bits of accuracy and resolution. You can have a conversation with Kepco's new MBT power supply.

Use IEEE 488.2, (CIIL or SCPI), IEEE 1118 (2 wire serial bus) or RS 232. Or, punch up your instructions on the keypad and watch the MBT respond on a large 2x16 character display-or back through your bus to its controller. Best of all, watch the MBT's low noise, linear-stabilized output delicately commune with your load, driving it precisely.

360 Watts, 12-bit resolution and accuracy in both voltage and current mode. Reversible polarity with optional built in relays. Self test calibration routines are built in.

BITBUS·SMART·PROGRAMMABLE·HIGH SPEED·UNI POLAR·BIPOLAR·DIGITAL·KEPCO

MBT MODEL TABLE

MODEL	OUTPUT VOLTAGE Volts	OUTPUT CURRENT Amperes
MBT 6-32MG	0-6	0-32
MBT 15-20MG	0-15	0-20
MBT 25-14MG	0-25	0-14
MBT 36-10MG	0-36	0-10
MBT 55-7MG	0-55	0-7
MBT 75-5MG	0-75	0-5
MBT 100-3.6MG	0-100	0-3.6
MBT 150-2.4MG	0-150	0-2.4

A single board computer is included in models with suffix "G". This enables the RS 232 & GPIB (IEEE 488.2) ports and allows an MBT to act as a "master" driving other power supplies. Models are available without the G for use as "slave" units and stand-alone service. To include the Output Enable and Polarity Reversal relays, add a suffix "R" to the model number.

Call/fax/write to Dept. NFF-05 for our new Kepco catalog.

Kepco, Inc. HQ / Eastern Region, 131-38 Sanford Avenue, Flushing, NY 11352 USA • Tel: (718) 461-7000 • Fax: (718) 767-1102
Western Region., 800 West Airport Freeway, Suite 320, LB 6018, Irving, TX 75062 USA • Tel: (214) 579-7746 • Fax: (214) 579-4608

KEPCO.
THE POWER SUPPLIER™
SINCE 1946

See us at Wescon 94 Kepco Booth 1448/50

READER SERVICE 96

WESCON/94 CONFRONTS INDUSTRY ISSUES

AS TECHNOLOGY CONTINUES TO RESHAPE THE ELECTRONICS WORLD, DESIGNERS HAVE TO WORK HARDER TO KEEP UP. WESCON AND IDEA/ MICROELETRONICS TRY TO HELP.

JOHN NOVELLINO

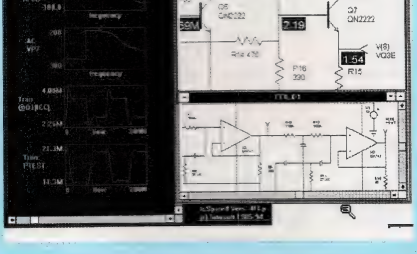
Recognizing the constant changes and innovations occurring in the electronics industry, Wescon/94 has adopted "Technology on the Move" as its theme. Supporting this theme are some two dozen applications-oriented technical sessions, broken down into four tracks: Emerging Technologies, Transportation Technology and Batteries, Computing, and Practical Issues. The show also features 12 short courses covering leading-edge technologies and several special sessions and conferences on such varied topics as the North American Free Tree Agreement (NAFTA) and ISO-9000 certification.

Back for its second year will be Idea/Microelectronics, an exposition held in conjunction with Wescon that focuses on the latest developments in ASICs, programmable devices, semiconductors, EDA tools, workstations, and engineering software. The eight technical sessions devoted to Idea/Microelectronics will look at new specialty memories, applications of boundary-scan design, field-programmable gate arrays (FPGAs), high-speed logic, advances in logic and gate-array architectures, and emerging digital communications technology.

Altogether, the 43rd Wescon is expected to draw more than 35,000 visitors

LOW-COST SPICE TOOL PERMITS UNLIMITED CIRCUIT SIZE

As a low-cost analog and mixed-signal circuit simulation system, ICAP/4Lite retains the main functions desired by most users and allows for unlimited circuit size. ICAP/4Lite is based on ICAP/4Windows, a full-featured version of Spice. Most low-cost Spice tools offer the traditional range of analyses but limit circuit size. Instead, ICAP/4Lite permits unlimited circuit size but trims features. Analyses performed by ICAP/4Lite include ac (frequency response), dc (sweeps and operating point), transient (nonlinear, time domain), and temperature (with global and individual element variations). The software includes an integrated schematic entry program that produces a complete Spice net list and directly drives the simulator. The schematic and net-list files both are upwardly compatible with ICAP/4Windows. In addition, the package contains a library of over 500 parts, including power models, RF devices, digital logic blocks, and ICs and op amps. Optional model libraries total over 4500 parts. ICAP/4Lite, which isn't copy protected, uses 32-bit code with Win32s extensions. It runs on Windows, Windows NT, and the upcoming Windows 4.0 (Chicago). ICAP/4Lite costs $595. Owners of any other ICAP product can buy ICAP/4Lite for $295 through October 15.


IsSpice4
File Edit Options Actions Window Help
Simulation Status: SAMPLE.ckt
SpiceNet
File Edit Draw Parts Options Actions Windows Help
SAMPLE.D1
2.89
3.67
2.19
1.54
Q6 QN2222
Q7 QN2222
V(11) VQ3C
V(8) VQ3E
R15
R16 390
frequency
time

***Intusoft**, P.O. Box 710, San Pedro, CA 90733-0710; (310) 833-0710.*

CIRCLE 700

Booth 3337

and have more than 1200 exhibits, according to show organizers. The event will be held at the Anaheim Convention Center in Anaheim, Calif., from Sept. 27-29. A number of special meetings, including nine short courses for Idea/Microelectronics, will be held on Monday, Sept. 26.

The show is continuing a trend, developed over the last three years, to offer a broad range of technical sessions that address issues and questions faced by electronics designers, according to Jim Lipman of VLSI Technology Inc., co-chairman of the Technical Program Committee. "With the addition of the Idea/Microelectronics sessions, we have expanded our offerings to include even more in-depth coverage of the rapidly changing ASIC market," says Lipman.

A significant new feature of this year's show is a high-level panel discussion entitled "System Design Challenges for RISC and CISC Processors." Participants will present the industry's views on the two competing processor architectures. The panel is jointly sponsored by Wescon-Idea/Microelectronics and Electronic Design and its parent company, Penton Publishing. Chairing the panel will be Dave Bursky, Electronic Design's Semiconductor Technology editor.

Panelists will include representatives from the Microprocessor Divisions of Intel and Motorola, Fujitsu Microelectronics, Hewlett-Packard, IBM Microelectronics Group, Integrated Device Technology, Silicon Graphics' MIPS Division, and Sun Microsystems. The meeting will be held on Tuesday, Sept. 27, from 5:00-7:00 P.M. in the convention center. Attendees will receive copies of presentations and technical material used by the panelists.

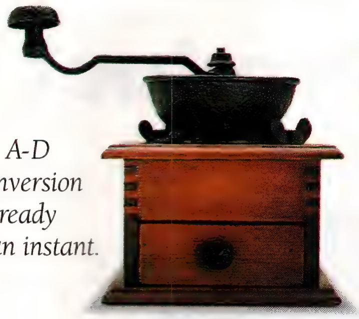
Wescon's short-course program is designed to complement the technical sessions with discussions of issues and developments facing the electronics and computer industries. A course called "High-Speed Board Design" targets systems designers, especially those working on circuits with clock frequencies over 25 MHz. "Introduction to Fuzzy Logic" is designed to supply engineers, technical managers, and technical marketers with an overview of the technology, applications, and implementations of fuzzy logic. Further information is available from "Applications of Neural Networks and Fuzzy Logic," which takes a practical, applications-oriented approach to the subject.

The importance of the automotive industry in general and electric vehicles in particular is reflected in a course titled "Electric Vehicles and Battery Technology," which complements a track of five sessions based on similar subjects. A course on "The ISO-9000 Quality Standard" aims at providing a comprehensive overview

WESCON/94 (W) AND IDEA/MICROELECTRONICS (I) TECHNICAL PROGRAM

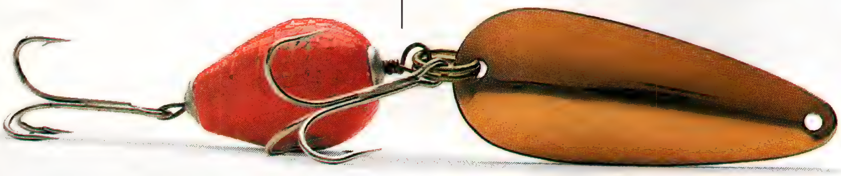
Day	Time	Emerging technologies	Transportation technology and batteries	Computing	*IDEA Microelectronics*	Practical issues
TUESDAY	9:30-11:30 A.M.	**Session W1** Emerging LAN technologies	**Session W2** Electric vehicles: New components	**Session W3** Formal methods in software and hardware design	**Session I1** New specialty memories: Intriguing and useful	**Session W4** Patent harmonization: An update (panel)
TUESDAY	2:00-4:00 P.M.	**Session W5** Wireless communication	**Session W6** Virtual-reality applications	**Session W7** Fuzzy logic and practical applications	**Session I2** Applications in boundary-scan design	**Session W8** Marketing high-technology products
WEDNESDAY	9:30-11:30 A.M.	**Session W9** Digital video compression	**Session W10** Electric vehicles	**Session W11** Mathematical software programs in engineering	**Session I3** Real-world applications for field-programmable gate-array devices	**Session W12** Software piracy and copyright protection (panel)
WEDNESDAY	12:30-2:30 P.M.	**Session W13** Quality-control techniques	**Session W14** Small, sealed rechargeable batteries: 1	**Session W15** Software in the engineering workplace	**Session I4** Logic synthesis for FPGAs	**Session W16** The rapid prototyping advantage: How rapid prototyping can improve productivity and cut design schedules
WEDNESDAY	3:00-5:00 P.M.	**Session W17** Power management for portable design	**Session W18** Small, sealed rechargeable batteries: 2	**Session W19** Fuzzy logic and neural networks	**Session I5** Issues and advancements in high-speed logic	**Session W20** Developing winning products and delivering them to market in less time
THURSDAY	9:30-11:30 A.M.	**Session W21** Virtual reality: A designer's tool	**Session W22** Will the California ZEV laws work? (panel)	**Session W23** Advanced information management	**Session I6** Advances in complex PLD (CPLD) architectures	**Session I7** Emerging digital communications technology
THURSDAY	12:30-2:30 P.M.	**Session W24** Biomedical engineering: New jobs in medical technology	**Session W25** Electric vehicles: New vehicles	**Session W26** Low-power techniques in microcontroller systems	**Session I8** Advances in FPGA architecture	

Arm your VME system for industrial control with A-D and servo-motor control modules.



A-D conversion ready in an instant.

Need network connections such as Ethernet, Serial, X.25 or SNA? We'll hook you up with all you need.



Satisfy any taste in VMEmodules by choosing from over 120 IndustryPack modules on the market.

We offer you a wide spectrum of O/S software choices.

Think Of This As A VME Smörgasboard.

The MotorolaVME product line is like a gourmet buffet. You take what you like, and you'll like what you take.

Make The Call, Not The Board.

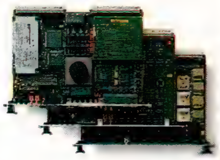
Motorola VME boards offer you more choices. More ways to get the features you need, at a price you can afford. When you select your board from Motorola, you'll save a lot more than time. Add networking options (such as Ethernet, Serial, X.25, SNA), memory, motor control, A-D conversion, graphics capabilities with either IndustryPack™ or VMEmodules.™

With more than 120 IndustryPack modules and over 3,000 VMEmodules available industry-wide, your options are unlimited, and your finished product will be dependable.

Flexible Performance, Inflexible Commitment.

Depend on Motorola VMEmodules for a variety of design needs. One of our boards can perform multiple tasks, saving you slots, cash, and hassle. And as your needs change, just add modules to your existing board.

While we serve up a huge menu of VME selections, there's one thing we won't consider changing: our Five-Year Warranty. Call Motorola and you'll get your just desserts.



Motorola VMEmodules let you select the features you need, at a price you can afford.

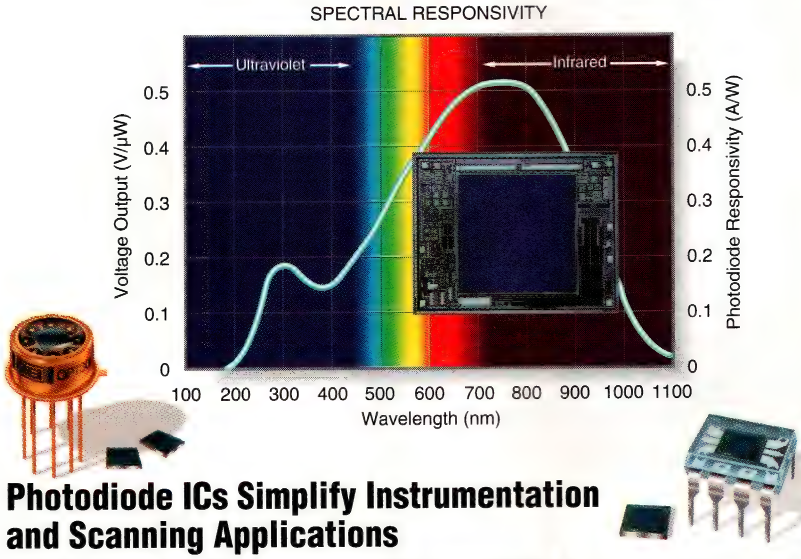
For More Information Contact Your Local Motorola Sales Office.

© Copyright 1994 Motorola, Inc. Motorola and the Motorola logo are registered trademarks of Motorola, Inc. "Because The Game Has Changed" and VMEmodule are trademarks of Motorola, Inc. All other products mentioned are trademarks or registered trademarks of their respective holders.

Australia	61-2-906-3855
Belgium	32-2-718-5582
China (PRC)	86-1-843-8237
France	33-1-4674-3560
Germany	49-40-236204-0
Hong Kong	852-966-3210
Italy	39-2-8220-239
Japan	81-3-3280-8461
Korea	82-2-720-0653
Netherlands	31-30-870857
Scandinavia	46-8-734-8800
Spain	34-1-329-0461
Taiwan	886-2-717-7089
United Kingdom	44-628-39121

MOTOROLA
Computer Group
Because The Game Has Changed™

New Product Update



Photodiode ICs Simplify Instrumentation and Scanning Applications

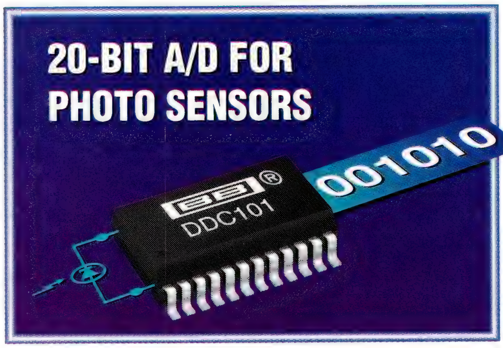
OPT202, OPT209, and OPT301 are low cost, photodiode/amplifier ICs for instrumentation, scanning, and sensing applications. All share common features: the large, sensitive photodiode; a 1MΩ feedback resistor; high responsivity, 0.45A/W; low dark errors; and a wide ±2.25 to ±18V supply range. OPT209 provides excellent performance for general purpose applications. OPT202's bandwidth is 50kHz—ideal for pulsed-light applications such as barcode scanners. OPT202 and OPT209 are packaged in 8-pin clear plastic DIPs. OPT301 provides improved ultraviolet response—an excellent choice for spectrophotometers and fluorescence detectors—and it's packaged in a hermetic TO-99.

READER SERVICE 208

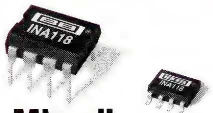
New Applications Handbook

This 425+ page handbook contains useful applications information for many of our successful products. Included are general information applications notes such as "Op Amp Performance Analysis" along with application notes for specialized products as a dual switched integrator. An index helps the user find just the right idea to solve an application problem. For a **FREE** copy, contact your local sales representative.

READER SERVICE 209


20-BIT A/D FOR PHOTO SENSORS
001010
DDC101

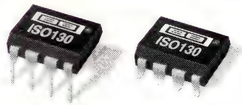
New



"Power Miser" Instrumentation Amp Consumes Only 350µA

INA118 is a precision instrumentation amp ideal for battery powered systems and other low power applications. It's a power miser—operates with power supplies as low as ±1.35V, or single supply operation to 2.7V. Quiescent current is only 350µA. Ideal for portable instruments, thermocouple amplification, medical instrumentation, and general purpose data acquisition designs—available in 8-pin DIP, SO-8 surface mount, and dice.

READER SERVICE 210



Low Cost Isolation Amp for Motor Control Applications

ISO130 is a high isolation-mode rejection, isolation amplifier suited for motor control applications. It's easy to use—no external components are needed. Key specifications are: 10kV/µs isolation–mode rejection, 85kHz large signal bandwidth, 4.6µV/°C V_{OS} drift, and single supply operation. ISO130 is available in a space-saving 8-pin plastic DIP and plastic gull-wing surface mount packages.

READER SERVICE 211

New 20-Bit A/D for Photosensors

DDC101 is a 20-bit, current input A/D converter designed for direct connection to photodiodes and other low level current output devices. It replaces an amplifier circuit, programmable-gain amplifier, and high resolution A/D converter—all on a single, monolithic chip. It's ideal for many precision instrumentation and process control applications including direct photosensor digitization, medical and chemical analyzers, and infrared pyrometry. Key specifications are: 20-bit resolution; 1.6ppm rms noise; up to 15kHz conversion rate, 2.5ppm of FSR, accuracy at low level; and 170mW power dissipation.

READER SERVICE 212

Need Fast Product Info?
FAX 602-741-3895

New

SCSI Termination Chip with Power-Down Mode

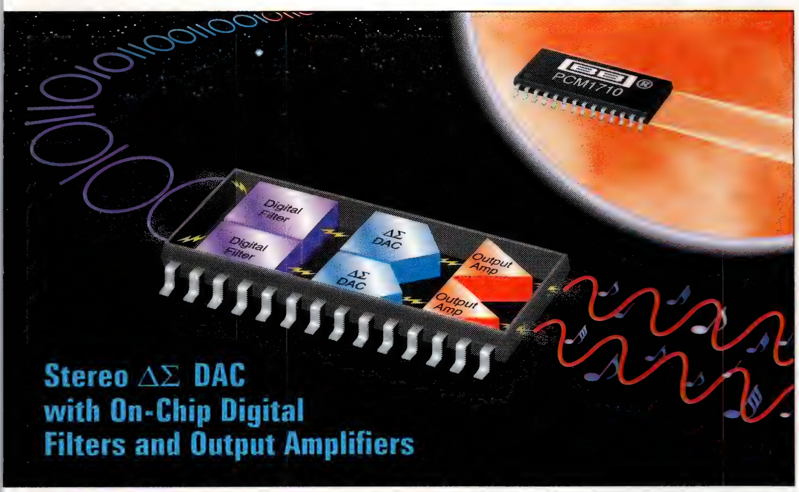
REG5601 is an 18-line active terminator for SCSI-2 circuitry. On-chip resistors and 2.9V regulator provide the prescribed 110Ω termination for low power dissipation a high speed data transmission. All line connections can be disconnected from the bus with a single logic control line to reduce standby power consumption. Key specs a 2.9V current-limited and thermally protected regulator, power-down mode of 150µA max, and output capacitance in disconnect mode of 10pF typ. Packaged in a 28-le surface mount package.

READER SERVICE 213

BURR - BROWN®

International Subsidiary Offices: Austria (43) 1 602 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504,
Japan (81) 33 586 8141, **Netherlands** (31) 3465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

New Product Update



New 20-Bit Delta-Sigma Audio D/A

PCM1710 is a low cost, dual voltage output, 20-bit delta-sigma D/A designed for digital audio applications. A digital filter and low noise output amplifier is included on-chip. It's ideal for high volume audio applications such as portable and automotive CD players, laser disk players, and musical instruments. Key specs are: stereo, 16- or 20-bits, 0.004% THD+N max, 95dB dynamic range typ, 110dB A-weighted SNR typ, 256fs/384fs selectable clock, 3.2Vp-p output, and an 8X over sampling filter with –62dB stop band attenuation and ±0.008dB pass band ripple. Available in a compact 28-pin surface mount package.

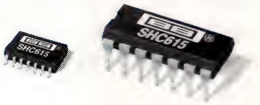
READER SERVICE 214

New

16-Bit D/A for Industrial Applications

DAC712 is a new 16-bit D/A designed and specified for industrial applications—it's ideal for ATE equipment, analog I/O boards, robotics, process controllers, and similar designs. Featuring a fast, 16-bit parallel, double-buffered interface for direct connection to industrial buses, DAC712 beats the competition in price, power, and package size. It's packaged in a 28-pin, "skinny" 0.3in. DIP—half the size of our competition! Power dissipation is a low 600mW, and prices have been cut, too! It's also available in a 28-lead SOIC package.

READER SERVICE 216

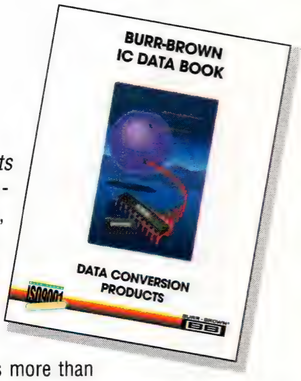


DC Restoration Circuit for Video

SHC615 is a unique DC restoration device ideal for high speed, precision applications. Designed to stabilize the performance of RF signals, use it as a fast phase comparator, synchron demodulator in PLL circuits, or RF pulse code mod/demod. SHC615 can also be configured as a sampling comparator. Key specs are: 750MHz bandwidth, 1700V/µs slew rate, 4nV/√Hz noise, 0.5MΩ output impedance, 600mW max power dissipation, and 10V voltage output. Available in a 14-pin plastic DIP or SOIC package.

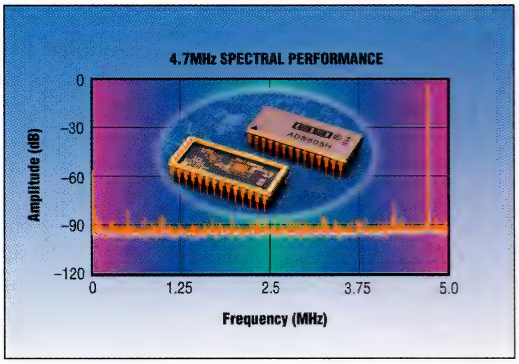
READER SERVICE 217

New Data Conversion Products IC Data Book



The *Data Conversion Products* IC Data Book contains complete product descriptions, specifications, applications tips, and ordering information for a broad line of high performance, high quality data conversion products. With over 950 pages, it offers more than 25 new high performance data conversion solutions. New products profiled include: A/D and D/A converters, data acquisition components, sample/hold amplifiers, V/F converters, multiplexers, and demonstration boards. The *Data Conversion Products* Data Book is **FREE** from any Burr-Brown sales office or representative.

READER SERVICE 215



Dynamic New 12-Bit, 10MSPS A/D

ADS605 is a 12-bit sampling A/D that provides the highest Nyquist performance in its product category at the lowest price. It's a complete device with wideband track/hold, 12-bit quantizer, timing circuitry, and low drift internal reference all in an economical 28-pin DIP. ADS605 is an excellent choice for demanding imaging, communications, and test/measurement applications. Both DC and dynamic AC specifications are guaranteed to Nyquist. Key specs are: 10MSPS sampling rate, –78dBc SFDR, ±0.5LSB DNL, 66dB SNR, 1.4W power dissipation, and 12-bit resolution.

READER SERVICE 218

Need Fast Product Info?
FAX 602-741-3895

New

Low Cost, High Accuracy 16-Bit D/A

DAC56 is a complete 16-bit, monolithic D/A—it's the most cost-effective, highest accuracy D/A available for the industrial market today! It's self-contained with a stable, low noise, internal zener voltage reference; high speed current switches; a resistor ladder network; and a low noise output op amp—all on a single chip. Use it for process control, ATE, and multiple channel applications. It's available in a 16-pin DIP and SOIC package.

READER SERVICE 219

BURR - BROWN®

International Subsidiary Offices: Austria (43) 1 602 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504,
Japan (81) 33 586 8141, **Netherlands** (31) 3465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

MEMORY TESTER IS FAST AND FLEXIBLE

The Eureka is a multibit memory/SIMM tester that can exercise memories at real cycle times down to less than 100 ns, which means a normal comprehensive test of a 16-Mbit module can be done in 12 seconds. The unit's analog pin drivers deliver a high current into large-capacitance loads, and Eureka can test chips with inputs from 0 to 5.5 V. Possessing an address field of 256 Mbits and a standard data width of 40 bits (144 bits cascaded), the system covers fast-page, write-per-bit, nibble, and static-column modes. Access time is as little as 5 ns, with a 2-ns resolution. The system's Flexware software package offers different levels of features to handle the needs of engineers, engineering management, and the production floor. Eureka prices start at $12,000.

***Computer Service Technology Inc.**, 2336 Lu Field Rd., Dallas, TX 75229; (214) 241-2662.*

CIRCLE 701

Booth 1749

of the ISO-9000 program. Included are details of the series of standards involved, their impact on an organization, and a model plan for achieving ISO-9000 certification. Subjects covered by some of the other courses are "Interactive Multimedia," "Accelerated Product Development," and "Direct-Broadcast Satellite Television."

Attendees desiring a more rounded understanding of ISO-9000 can join in a full-day conference on the subject on the Monday of show week. The session will discuss the benefits of certification, especially its importance for doing business in Europe and how it can help when working with the U.S. Department of Defense.

A panel of industry experts who have gone through the process will offer advice on managing ISO-9000 implementation, selecting a registrar, keeping the program on track, costs, and the effect of recent changes. Several registrar lead auditors will be on hand to guide participants through the registration audit process and discuss registration options, audit criteria, and how to handle disagreements with the auditor.

The communications arena is sure to affect the success of the electronics industry in the next few years, and an important area in this field is the local-area network (LAN). A technical session entitled "Emerging LAN Architectures" will examine several LAN alternatives that arose in response to the changing needs of network users.

One paper in this session, "Implementing a Multimedia-Capable Network Using ATM and IEEE-802.9a (Isochronous Ethernet) Transport Technologies," describes the characteristics networks must have if they're to carry isochronous information. The paper's authors, Andy Moorwood and Steve Bauer of National Semiconductor Corp., Santa Clara, Calif., note that the computing workplace environment is changing in a way that requires networks to carry video signals and CD-quality sound. Therefore, networks will have to handle high-speed real-time traffic as well as fast packet data signals.

MAPPING DATA TO ATM

The paper describes the issues encountered in mapping data from an IEEE-802.9a isochronous network onto asynchronous-transfer-mode (ATM) networks and vice versa. Three specific techniques are described in detail: circuit mode, multiplexed cycle mode, and multiplexed circuit mode. Each is discussed from the standpoint of delay, efficiency, and cost.

Under the Idea/Microelectronics banner, a session entitled "Applications in Boundary-Scan Design" describes several implementations of the IEEE-1149.1 standard (sometimes referred to as JTAG). Since its approval in 1990, the standard has received much support as a way to perform manufacturing testing on pc boards that don't offer the physical access needed for bed-of-nails testing.

Techniques also are being developed to use boundary-scan testing outside of its role of pc-board manufacturing testing. For example, the

80C166 EMULATOR RUNS REAL TIME TO 40 MHZ

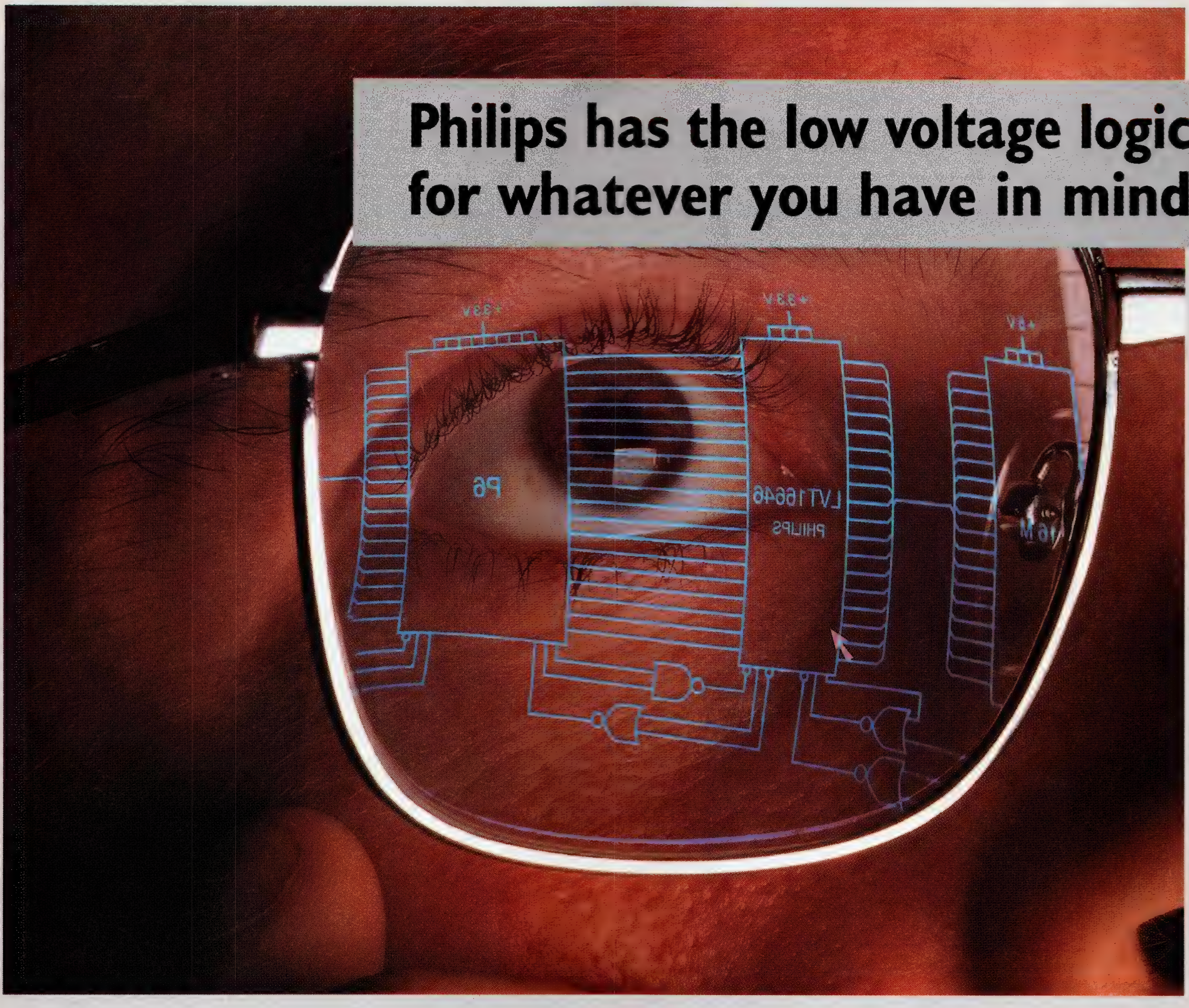
The ET-iC166 in-circuit emulator offers real-time emulation at up to 40 MHz with no wait states for prototype debugging of systems based on the Siemens 80C166 microcontroller family. The clock source is switchable between the target system and the on-board programmable oscillator, with rates being software selectable from 1 to 40 MHz in 1-kHz steps. The unit performs source-level debugging in single steps or line steps with breakpoints. Features include language support for an array of third-party assemblers, C compilers, and linkers. The ET-iC166 plugs into a 286-based or higher PC through the COM or LPT port, or through an optional high-speed, bidirectional parallel interface. The operating software runs in MS-DOS or in a DOS window under Windows. Required RAM is 2 Mbytes. The ET-iC166 comes with 256 kbytes of overlay RAM and 128,000 breakpoints for $7200. An 8-k-by-144-bit trace buffer costs $2995.

***Emulation Technology Inc.**, 2344 Walsh Ave., Bldg. F, Santa Clara, CA 95051-1301; (408) 982-0660.*

CIRCLE 702

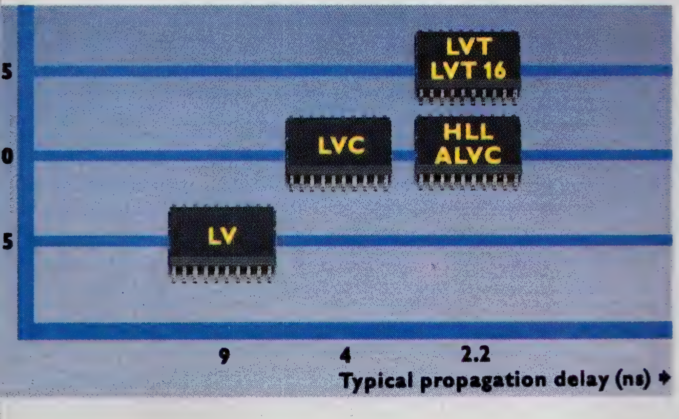
Booth 1554

Philips has the low voltage logic for whatever you have in mind.



It's a real eye-opener.

Six families of low voltage logic, each delivering a different combination of speed, drive and power consumption. No-one else can offer such a broad spectrum of solutions.



To help you focus on your job, all Philips low voltage logic ICs are designed from scratch with industry-standard features. The BiCMOS LVT offers 3-5 V mixed mode capability, and HLL is quite simply the world's fastest 3 V CMOS logic.

Small designs are catered for with very small SSOP and TSSOP packages. And we haven't overlooked your need for security of supply. Alternate sourcing agreements are firmly in place for all families except the unique HLL range.

So if your design calls for low voltage logic, contact Philips. You can be sure we'll have just what you're looking for.

USA, call: 1-800-447-1500 ext. 1140.
Europe, fax: +31-40-724825, quoting 'LV logic.'
S.E. Asia, fax: +886 (2) 382-4485, quoting 'LV logic.'

Philips
Semiconductors

PHILIPS

READER SERVICE 181

Power Macintosh is a trademark of Apple Computer, Inc. IBM is a registered trademark and PowerPC, the PowerPC logo, PowerPC 601, PowerPC 603, PowerPC 604, PowerPC 620, RISC System/6000 and IBM Microelectronics are trademarks of the International Business Machines Corporation. © 1994 IBM Corp.

At a certain point, everyone understands the benefits of RISC over CISC.

In the debate over which microprocessor technology is best for today's emerging computing needs, there's one point on which everyone can agree.

It's the one in the middle of the chart to your left. And what it illustrates is that, over time, microprocessors powered by RISC technology will outperform those driven by 15-year-old CISC architecture.

Update

◆

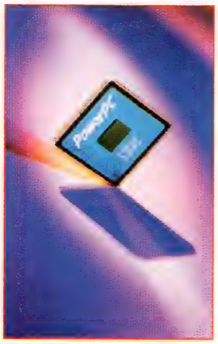
In July, we shipped our one millionth PowerPC 601 microprocessor, after just ten months of production.

That's vital news for everyone who makes or uses personal computers. Because the fact is, it takes the extraordinary processing power of RISC chips like our PowerPC™ family to drive today's and tomorrow's leading-edge computers and software. Which makes possible such innovative applications as realtime voice dictation, wireless networks, voice and handwriting recognition, and full-screen, full-motion multimedia, to name a few.

Some of these startling capabilities are already at work in advanced PCs and workstations. Two acclaimed examples are IBM's RISC System/6000™ workstation and Apple's Power Macintosh™ series, both powered by our PowerPC 601.™ Smaller, faster and less expensive to produce than non-RISC chips, the 601 makes it possible for these systems to run faster than CISC-based models, yet cost roughly the same.

Of course, all these advantages are hardly accidental. The fact is, because RISC (Reduced Instruction Set Computing) processors carry only the most frequently used instructions, they offer streamlined performance levels that CISC (Complex Instruction Set Computing) chips simply can't match. Specifically, the simpler instructions implemented in RISC processors are typically executed in one system clock cycle, while CISC instructions often take five or even fifty system clock cycles to execute. The result is that the average number of system clock cycles per instruction in RISC typically eliminates advantages touted by CISC manufacturers.

And the best is yet to come. Since RISC-based PowerPC chips are built with IBM superscalar technology, we can all look forward to even greater performance benefits down the road. Right this minute, in fact, systems from palmtops to high-end workstations are under development utilizing IBM's PowerPC 603,™ PowerPC 604™ and PowerPC 620.™



To learn how IBM PowerPC microprocessors can work for you, call IBM Microelectronics™ Division at **1-800-PowerPC**, ext. 1430 (OEMs), ext. 1440 (programmers) and ext. 1450 (end users).

Once you know the facts about PowerPC, choosing anything less will seem pointless.

PowerPC™

IBM®

READER SERVICE 155

PROGRAMMER SUPPORTS MANY NEW DEVICE TYPES

The APRO-PLUS adds LCMOS EPLDs, PALs, LGALs, and PEELs to the list of devices programmed by the APRO model. Flash memories, (E)EPROMs, and microcontrollers are already handled by APRO. The new unit comes with a 40-pin DIP socket that programs all DIP devices down to eight pins. Adapters accommodate all other packages, including PLCC, LCC, TSOP, QFP, and SOIC. With its 8 Mbits of RAM and the proprietary Turbo-Mapping and Auto-Sense technology, APRO-PLUS can perform low-volume production programming. Auto-Sense senses contact with the device and automatically initiates the program cycle without user intervention. Multiple file formats are supported. The programmer operates off any RS-232 port and comes with PC-driven software that offers data speeds to 115.2 kbaud. Set- and split-mode programming are supported, as well as shuffle and fill-find-delete functions. The APRO-PLUS costs $1295 and is available from stock. Upgrades from the original APRO model cost $400.

***System General Corp.**, 1603-A S. Main St., Milpitas, CA 95035; (408) 263-6667.*

CIRCLE 703

Booth 3242

session includes a paper on "Using IEEE-1149.1 for In-Circuit Emulation" by Mark Winters of Corelis Inc., Cerritos, Calif. And session chairman Gary O'Donnell of National Semiconductor Corp., South Portland, Maine, will relate the standard to efforts to enhance system testability. His paper is titled "Building Multidrop and Hierarchical System Test With 1149.1."

VIDEO CONTROLLER BIST

Another offering in this session, "Self-Testable Video Controllers," includes a discussion of the system-level integration of built-in self-test (BIST) to boundary-scan testing. The paper, by Lahouari Sebaa and others from Western Digital Corp., Irvine, Calif., presents several BIST techniques for video controllers. BIST circuitry is shown to illustrate the concept of structural and functional coverage at the chip, board, and system levels. A scheme based on reconfiguring existing functional registers and control signals to implement the BIST circuitry is described in detail. The functionality of the whole unit under test is covered at the chip and board levels. Included is a cost analysis revealing the savings created by BIST.

The interesting field of specialty memories also is highlighted at this year's show in a session called "New Specialty Memories: Intriguing and Useful." A specialty memory is a device that includes RAM and logic on the same chip. The combination is typically faster and more powerful than having the same functionality on separate chips.

The session includes a paper by Mark Muegge and Michael G. Davis of Quality Semiconductor Inc., Santa Clara, Calif., that describes a "High-Performance Bidirectional FIFO for Bus-Interface Applications." The authors note that for today's CPU requirements, even 10-ns access times for traditional FIFO interfaces may not suffice.

However, clocked interfaces offer better use of the memory bandwidth and data rates of 66 MHz and beyond. Because it's a register-like interface with data and control inputs accepted at the rising edge of the clock input, the clocked interface's only critical timing parameters for input signals are setup and hold times around the clock edge. As a result, the device can use free-running system clocks without external gating or glue logic.

The specific device described is a 36-bit-wide, 4-kword-deep unit with 80-MHz speed. Other features include metastable, hardened flags; an eight-transistor memory cell for better stability; and an asynchronous Output Enable for tristating the data bus.

The growing popularity of multimedia systems and the approach of high-definition television have designers searching for better ways to squeeze video images into smaller bandwidths and memories. The "Digital Video Compression" session tackles the subject head on.

PORTABLE RECORDER OFFERS UP TO 30 CHANNELS TO 500 V PEAK

The Dash 10 portable chart recorder is available with channel counts of from 10 to 30. The unit records signals ranging from 50 mV to 500 V peak (isolated) at frequencies from dc to 25 kHz. Chart speeds of up to 200 mm/s are available. Features include 300-dpi laser-quality printing, 11-in. wide charts, built-in signal conditioning, a floppy-disk drive, and 1.2 Mbytes of RAM per channel for data capture. The Dash 10 has an internal rechargeable battery and a bright high-response vacuum fluorescent monitor. The 10-channel version of the Dash 10 costs $11,950.

***Astro-Med Inc.**, Astro-Med Industrial Park, 600 E. Greenwich Ave., West Warwick, RI 02893; (401) 828-4000.*

CIRCLE 704

Booth 3242

One-stop shielding.

For half a century, Instrument Specialties has led the way in EMI/RFI shielding. Today we are the supplier of choice for beryllium copper (BeCu) gasketing. BeCu offers formidable tensile strength, exceptional stability, superior thermal/electrical conductivity and ease of fabrication.

One-stop shopping for *all* your EMI shielding.

But more than 250 BeCu configurations were just the beginning. Instrument Specialties now offers wire mesh, conductive elastomers, vent panels and air filters. A complete line of EMI/RFI shielding solutions is on our shelf and ready to ship. Plus specialized platings and custom capabilities.

We want to be up front about our design help.

Instrument Specialties engineers will work with yours right from the drawing board stage. Our Finite Element Analysis simulates real-life working conditions. With CAD/CAM, photoetching, wire EDM and other state-of-the-art technologies, we help you achieve a total shielding solution. And a lot fewer headaches.

Million dollar expansion of testing capability.

A major capital investment has dramatically upgraded our ability to perform certified testing for all worldwide EMC specifications and standards in compliance with ISO-9000 requirements. At our facility or yours. For full facts... for our new color brochure...for one-stop shielding, please write, call or fax today.

Instrument Specialties

Where Shielding is a Science

Headquarters: Delaware Water Gap, PA 18327-0136
TEL: 717-424-8510 FAX: 717-424-6213
Western Division: 505 Porter Way, Placentia, CA 92670
TEL: 714-579-7100 FAX: 714-579-7105
European Division: Champ Tignée 34, 4671 Barchon, Belgium
TEL: +32-41-877170 FAX: +32-41-877175

Japan: Kitagawa Industries Co., Ltd., 052-261-5521; **Taiwan:** Intermark Taiwan Co., Ltd., 052-261-2740; **Korea:** Korea Microwave Sales Co., 82-331-33-9985; **Singapore, Malaysia, Indonesia, Thailand, Philippines:** Glocom Mktg Pte Ltd., 65-353-1791; **Australia, New Zealand, Pacific Islands:** RFI Industries Pty Ltd., 61-3-762-6733; **India:** RFI Electronic Ind. Ltd., 91-842-848358; **Hong Kong:** Bel Components Ltd., 852-327-6880

READER SERVICE 163

Three papers discuss a compression algorithm based on a new information theory called autosophy.

Session chairman Klaus Holtz, president of Omni Dimensional Networks, San Francisco, Calif., will present an overview paper, "HDTV Image Compression: MPEG versus Autosophy." Holtz describes the advantages of autosophy compared with MPEG-2, the standard used by many vendors in multimedia compression systems. He notes that the hardware to run the MPEG compressions at 30 frames/s does not yet exist. Moreover, final systems will probably be very complex, expensive, and hard to maintain, while producing images with barely tolerable distortion. On the other hand, Holtz continues, a lossless compression scheme based on autosophy promises superior performance at a much lower cost per system.

A paper by Alfred Lettieri, president of Applied Autosophy, Reseda, Calif., describes the technique as it applies to "Storing Multimedia Images in a PC." Lettieri notes that experimental data from tests using a 486-based PC suggest that the algorithm may provide a much better way to store images in a personal computer. But live animation and on-screen teleconferencing would require graphics boards that are slightly larger and more expensive than conventional boards, he says.

The third paper discusses a "brain-like, self-learning" autosophy database that reduces storage requirements by storing information in a mathematical hyperspace. According to Hubert Love, a consultant from La Habra, Calif., the more information that is stored in the database, the less space that is needed to store additional information. Besides high compression, the new technique allows near instant information search access, says Love. This is accomplished by using content-addressable memories, which are independent of database size.

The paper, "Storing Multimedia Database Information in Hyperspace," says that the system can repair itself by automatically relearning information stored in defective memory. Autosophy databases can even be "educated" to totally organize their own internal data storage without programming, says Love.

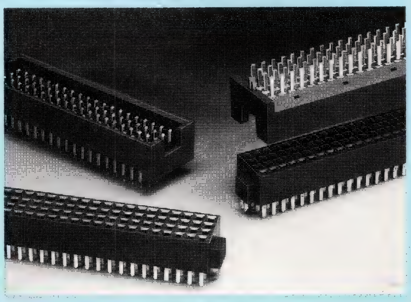
Field-programmable gate arrays are becoming more popular as solutions to design problems. One reason is that they can be reprogrammed as often as needed in the field, allowing design changes to hardware even after it's in service. Idea/Microelectronics devotes three entire sessions to FPGAs: one involving real-world applications for the devices, another presenting logic-synthesis techniques, and the third discussing advances in FPGA architectures.

In the applications session, Brad Fawcett of Xilinx Inc., San Jose, Calif., writes about "Using Reconfigurable FPGAs in Test Equipment Applications." Fawcett describes a microprocessor-based board tester that uses FPGAs to create the interface to the unit under test. By downloading the appropriate configuration files, users can change the interface and test logic to implement the desired test procedure. The FPGAs also make it easier to support new microprocessors as they become available.

In another application, a telecom-

FOUR-ROW 0.050-IN. CONNECTORS HOLD UP TO 50 PINS PER ROW

The MOLC and FOLC Series four-row male and female 0.050-by-0.050-in. strip connector sets now come in pin counts from 5 to 50 per row.



The interconnects are available for through-hole soldering; surface-mount versions are being developed. The three-finger contacts are stamped and formed with soft beryllium copper and then heat-treated to optimize spring properties, which ensures consistent, reliable contacts. The connectors' high-temperature LCP insulators are suitable for most IR soldering processes. The phosphor bronze 0.018-in. diameter male pins are shrouded for added protection. Depending on quantities and options, prices start at $0.10 per pin per mated pair. Delivery is in seven days.

Samtec Inc., *P.O. Box 1147, New Albany, IN 47151-1147; (800) 726-8329 or (812) 944-6733.*

CIRCLE 705

Booth 1590

PASSIVE ICs SIMPLIFY TERMINATIONS, FILTERING

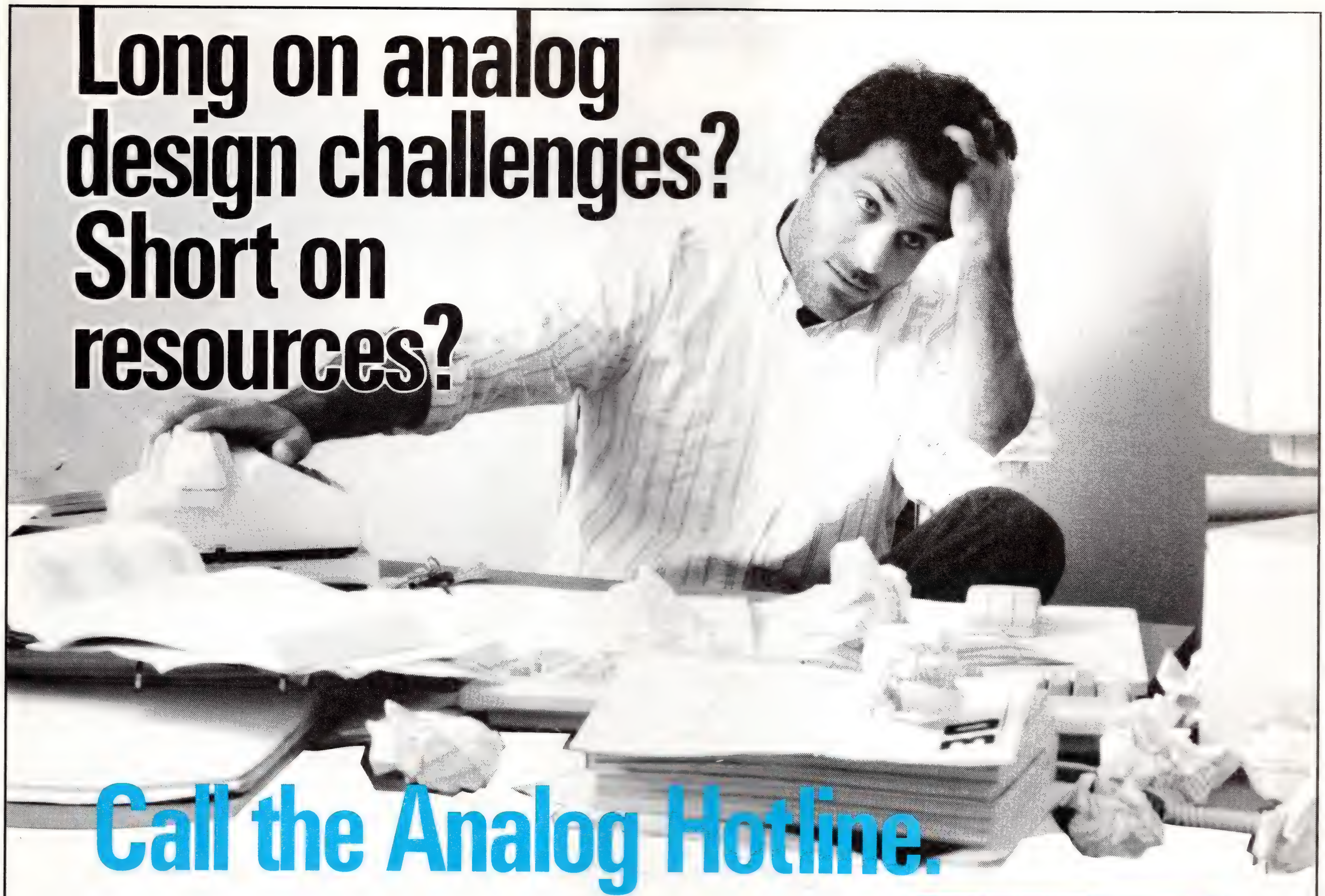
The IPEC (Integrated Passive Electronic Components) family of products includes ac termination and EMI/RFI filtering components that help board-level and system designers rapidly select, configure, and layout passive components. The components come in a wide array of package types, including the SOT, which takes up 50%-70% less board space than that needed by multilayer ceramic chips. The components are ideal for terminating or filtering high-speed bus lines, especially in 32- and 64-bit-wide applications. Their size makes the components suitable for workstations, notebook PCs, personal digital assistants, PCMCIA devices, and wireless communications products.

California Micro Devices Corp., *215 Topaz St., Milpitas, CA 95035-5430; (408) 263-3214.*

CIRCLE 706

Booth 3480

Long on analog design challenges? Short on resources?



Call the Analog Hotline.

SPG can make your job easier.

SPG delivers unparalleled analog expertise. We've accumulated hundreds of man years of experience designing, developing and putting into manufacture a wide variety of analog and mixed-signal integrated circuits and subsystems. When you're faced with seemingly insurmountable analog design demands, SPG is your source for answers … and peace of mind.

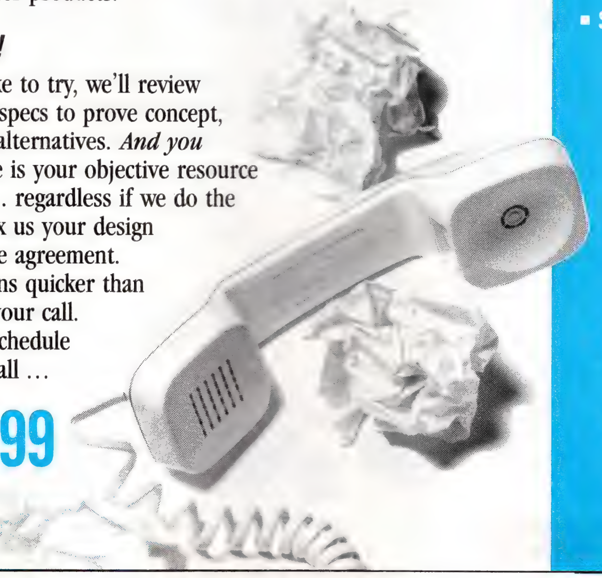
Bring your products to market quicker and for less cost.

SPG design teams will develop a strong partnership with you to examine your needs, establish parameters and tolerances, generate a realistic timetable, and seek out the optimum paths to successful implementation. **We'll prototype your project for significantly less than other vendors … guaranteed.** Whether you need start-to-finish assistance or expert advice along the way, SPG integrates an unrivaled level of customer service and performance with a mutual desire to develop better products.

Just call. We want to help!

If you have a design you'd like to try, we'll review your initial sketches, suggest specs to prove concept, and propose possible design alternatives. *And you don't pay a cent.* Our hotline is your objective resource for any questions you have … regardless if we do the work or not. You can even fax us your design sketches with a non-disclosure agreement. We'll provide recommendations quicker than many companies will return your call. For more information or to schedule a Free Design Consultation, call …

(602) 892-1399



Specialties

- Wireless
- Telecommunications
- Medical electronics
- Power electronics
- Bus drivers/transceivers
- Data acquisition
- Instrumentation

Complete service

- Turnkey custom semiconductor designs and products
- Single- and multi-chip modules, hybrids and PCBs
- System design and partitioning
- Cost reductions
- Concurrent engineering
- Simulation
- Device characterization
- Signal integrity analysis
- Fault grading
- Test program development

SPG

The Analog Specialists

561 East Elliot Road, Suite 171
Chandler, Arizona 85225
Phone: (602) 892-1399
Fax: (602) 892-1782

READER SERVICE 242

munications protocol analyzer can be set up to supply either fixed or pseudorandom patterns for T1 burst-error-rate testing. And when fractional T1 testing became necessary, the analyzer's designers produced a new FPGA configuration to support the tests without having to change the hardware.

Tighter schedules and higher performance and functionality goals make logic synthesis a key to using FPGAs today, notes Steve Eichenlaub in his paper, "Getting the Best from an FPGA Via Logic Synthesis." But it's only one step in the overall design process. The paper concentrates on how logic synthesis can help achieve optimal designs across multiple FPGA architectures without sacrificing results in any one device type.

Eichlaub notes than unlike ASICs, which almost universally use a sea-of-gates architecture, FPGAs employ a diverse set of dissimilar architectures, each optimized for a particular application. Therefore, without logic synthesis, the time-to-market advantage offered by FPGAs could be lost while designers struggle over the right architecture and try to maximize performance and utilization.

The author discusses the top-down FPGA design flow, including language-based design, multilevel simulation, design retargeting (for example, to or from ASICs), and physical implementation. Actual examples are included to illustrate successful designs and the trade-offs involved.

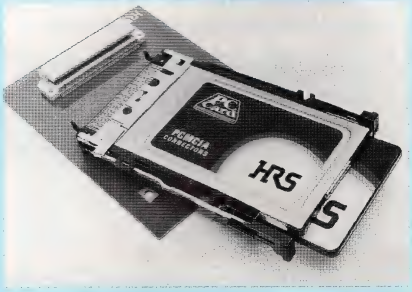
A panel session on "Software Piracy & Copyright Protection" will include members of the Business Software Alliance, which represents many of the leading U.S. software publishers. The BSA maintains programs in more than 50 countries, including the U.S., aimed at eliminating software piracy.

The session's organizers stress that information managers must know how to protect their computer systems from viruses that can be spread by unlicensed software and how to protect themselves from potential liability, as well as the importance of data security. Piracy, which is a felony in the U.S., costs the software industry more than $12 billion a year worldwide, according to the organizers.

A special conference on NAFTA will offer help on establishing business relationships in the countries covered by the agreement: Canada, Mexico, and the U.S. Topics to be addressed include financial assistance for electronics companies and dis-

TWO-SLOT SMT-TO-BOARD PC-CARD CONNECTOR OFFERS VISUAL ACCESS

A dual-slot SMT-to-board PC card connector, the IC8, features two-piece construction to supply full access for visual inspection of solder terminations. Allowing two cards per device is important for designers of portable computers, which must meet PCMCIA 2.0 and JEIDA Version 4.1 standards for Type I, II, and III cards. The IC8 comes in either standard or reverse configuration and accepts Type I, II, or III cards in either slot, both of which have ejectors. The device comes with no standoffs or with 2.5- or 5-mm standoffs. The IC8 is 11.6 mm high, and contact spacing on the connector is 1.27 mm with 136 pins in 2-by-2 rows. The IC8 costs $11 each in OEM quantities.



Hirose Electric (USA) Inc., *2688 Westhills Ct., Simi Valley, CA 93065-6235; (800) 879-8071 or (805) 522-7958.*

CIRCLE 707

Booth 3493

JOYSTICKS AND TRACKBALLS FEATURE HIGH RELIABILITY

Thanks to their smaller sizes, several additions to a line of industrial-quality joystick and trackball controls are well-suited for limited-space applications in which reliability is critical. The units are come in panel-mount and stand-alone versions. Users can select joysticks in single-, dual-, and three-axis configurations, and with a variety of handles. The units, which have a stainless steel shaft and a glass-filled nylon housing, have a minimum life of 5 million movements. Options include spring-centering or friction-positive true positioning; multiple bezel designs, including a rubber boot to seal out dust and moisture; and potentiometers ranging from 5 kΩ to 130 kΩ. The trackballs are plug-compatible with most computers and work with any mouse software. They use a phenolic resin ball enclosed in a glass-filled nylon housing, and have a minimum life of 5 million 180° rotations. An optomechanical design includes stainless-steel shafts and ball bearings. The desktop model is comes with a shielded cable assembly. Prices range from $33 to $224 each. Quantity discounts are available.

CH Products, *970 Park Center Dr., Vista, CA 92083; (619) 598-2518.*

CIRCLE 708

Booth 2587

3M boardmount connectors come in all shapes, sizes and applications.

3M
Boardlevel Engineering Guide
Electronic Interconnection Solutions for Boardlevel Applications from 3M
Product Information Kit
3M
Boardmount Connectors

Naturally, we're giving samples.

We've always been known for our high-quality wiremount connectors. Shouldn't the world know about our *boardmount* connectors, too?

Well, we can get you a complete line of boardmount products: shrouded headers, in both low-profile and latch-eject models; shunts; pin strips. Polarized sockets, straight and right-angled. D-sub connectors.

We can get you high-temperature bodies, true surface-mounts and through-boards, top and bottom. Choose your pin length. Choose your plating. Great for board-stacking. Plus delivery when promised.

We're out to make your life much simpler when it comes to boardmounts. A call to 800-328-0016, ext. 100, will get you our new Boardmount Engineering Guide—it's free. And qualify you for samples of 3M boardmount connectors at the same time.

3M Electronic Products Division, 6801 River Place Boulevard, Austin, TX 78726.

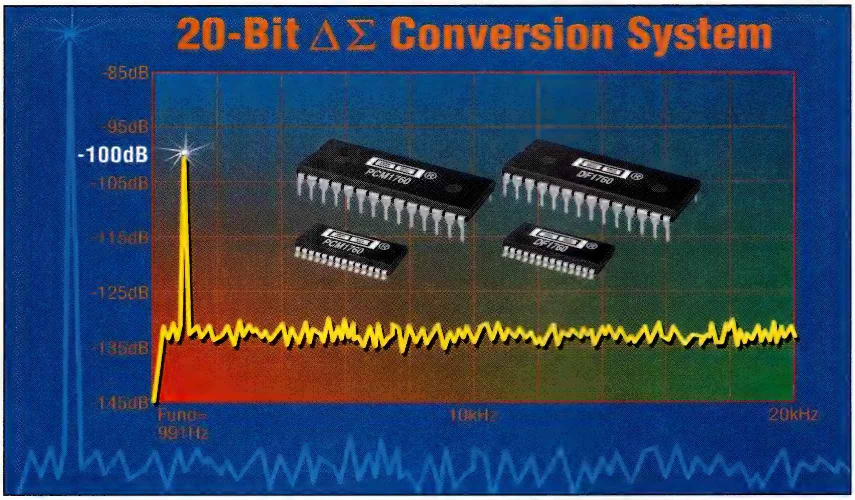
3M *Innovation*

©1994, 3M

READER SERVICE 256

BURR-BROWN ISO9001 CERTIFIED

New Product Update

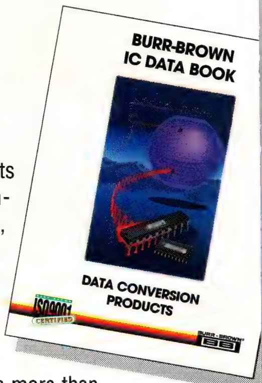


New 20-Bit Digital Audio ADC System

PCM1760 stereo delta-sigma modulator, together with its matched DF1760 digital filter, provide professional digital audio designers the best combination of analog-to-digital converter performance available for under $30! The system offers 20-bit resolution, wide 108dB dynamic range, very low –92dB THD+N, and clear 110dB SNR. PCM1760 and DF1760 are available in 28-pin DIP and SOIC. PCM1760 operates from ±5V supplies, DF1760 from a single 5V supply.

READER SERVICE 282

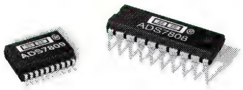
New Data Conversion Products IC Data Book



The Data Conversion Products IC Data Book contains complete product descriptions, specifications, applications tips, and ordering information for a broad line of high performance, high quality data conversion products. With over 950 pages, it offers more than 25 new high performance data conversion solutions. New products profiled include: A/D and D/A converters, da acquisition components, sample/hold amplifiers, V converters, multiplexers, and demonstration boards. The Da Conversion Products Data Book is **FREE** from any Burr-Brov sales office or representative.

READER SERVICE 283

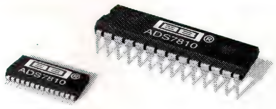
New



12- and 16-Bit Serial Out, 100kHz Sampling A/Ds

ADS7808 and ADS7809 are low cost, general purpose, serial output, CMOS sampling A/Ds. Both deliver 100kHz sampling rates with very low 100mW power dissipation using a single +5V supply. Ideal for many low power, portable applications requiring high sampling rates with superior accuracy and spectral purity, they're perfect for spectrum analyzers, portable oscilloscopes and vibration analyzers, medical electronics, and process control applications—where their serial output simplifies needed isolation. Available in 20-pin 0.3" plastic DIPs and SOICs.

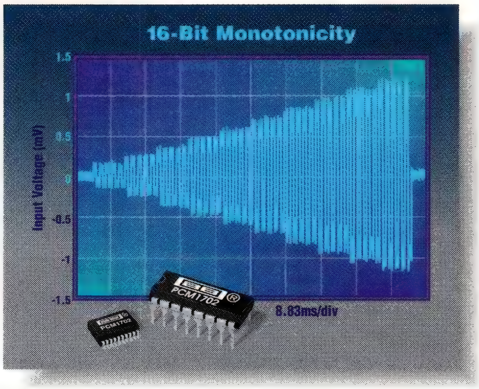
READER SERVICE 284



New 12-Bit, Low Power, 800kHz Sampling A/D

ADS7810's 800kHz sampling rate makes it the world's fastest, 12-bit, monolithic SAR ever—60% faster than its closest competitor! Its high speed, small size, low power, low cost, and excellent Nyquist performance make it ideal for data acquisition, DSP boards, and image processing/scanning applications. Key specs include: 800kHz min sampling rate, 12 bits resolution, 70dB min SINAD with 250kHz input, ±0.5LSB max INL, ±0.9LSB max DNL, and 250mW max power dissipation. Available in 28-pin 0.3" plastic DIP, SOIC and die.

READER SERVICE 285



20-Bit BiCMOS DAC

PCM1702's unique architecture produces a 20-bit DAC wit high dynamic range, high SNR, and very low distortio Processed using BiCMOS technology, it has very low powe consumption and is packaged in a compact 16-pin plastic DI or 20-pin SOP. PCM1702 is an unbeatable choice for high-en CD players, musical instrumentation and professional audi applications. Key specs include: –96dB max THD+N, 104d typ dynamic range, 110dB typ SNR, 200ns typ settling tim and 150mW typ power dissipation.

READER SERVICE 286

New

+5V Voltage Reference Guarantees Long-Term Stability

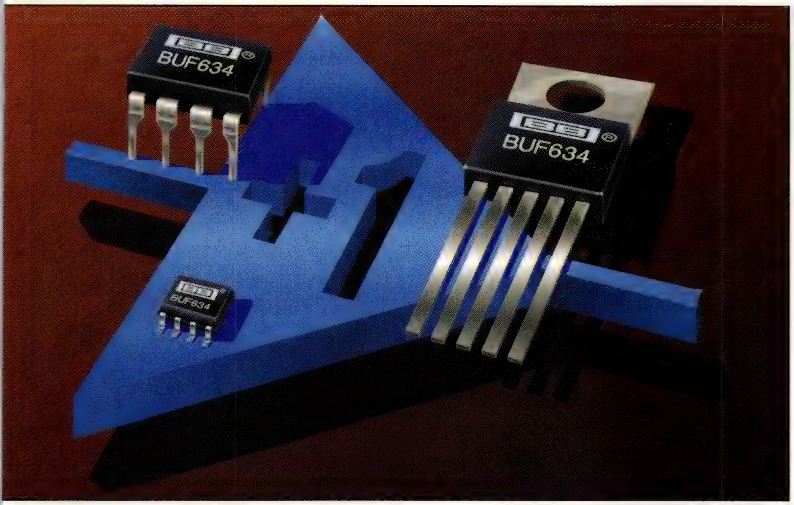
REF05 is a precision +5V voltage reference that's a pin for pin replacement for the industry standard REF-05. Its guaranteed long-term output voltage drift of 25ppm/1C hours max is 4 times more stable over extended use than the closest competitor. Key specs are: +5V ±0.1% max output voltage, 8.5ppm/°C max temperature stability, 10µV (0.1Hz to 10Hz) noise, 0.008% max line regulation, 0.005%/mA max load regulation, 1.4mA max quiescent current, and 8VDC to 40VDC supply range. Available in an 8-le hermetic TO-99.

READER SERVICE 287

BURR-BROWN®

International Subsidiary Offices: Austria (43) 1 602 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 3465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

New Product Update



ew 250mA Buffer Amp Slews at 2000V/µs

634 is a high speed, unity-gain buffer amplifier that delivers 250mA output and 2000V/µs slew —all in a tiny SO-8 package. Its low price, high performance, rugged monolithic design, and ease se make BUF634 ideal for a wide range of general purpose applications. It's an excellent driver for es, solenoids, video, and even headphones. BUF634 comes in three different packages: an SO-8 ace mount, an 8-pin plastic DIP, and a 5-pin TO-220.

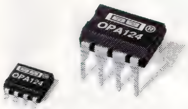
READER SERVICE 288

New Linear Products IC Data Book

The Linear Products IC Data Book contains complete product descriptions, specifications, applications tips, and ordering information for a broad line of high performance, high quality linear products. Its 1100+ pages give designers more than 30 new high performance linear ICs. New products profiled include: operational amplifiers, instrumentation amplifiers, isolation products, power operational amplifiers, references, regulators, and demonstration boards. The Linear Products Data Book is **FREE** from any Burr-Brown sales office or representative.

READER SERVICE 289

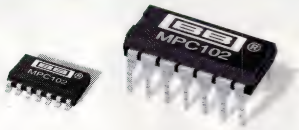
ew



w Noise, Precision fet® Op Amp

124 is a precision, monolithic FET op amp delivers low bias current, noise, voltage et, and drift plus high open loop gain common mode rejection. Its versatility, ll size, and low price make it ideal for ytical and laboratory instrumentation, data uisition, test/medical equipment, and optotronics. Key specs include: 6nV/$\sqrt{Hz}$ Hz) voltage noise, 1pA max bias current, /°C max drift, 120dB min open loop gain, dB min common mode rejection, and µV max offset. Available in compact 8-pin ace mount and plastic DIP packages.

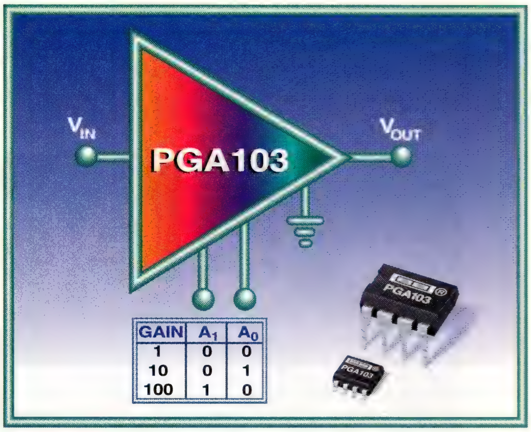
READER SERVICE 290



2 x 1 Dual, Video Multiplexer

MPC102 is a dual, 2 x 1 signal multiplexer that distributes and routes wideband analog and digital signals at a high data rate. Designed for high-definition television and broadcast equipment, its excellent harmonic and dynamic specifications are also ideal for radar, communications, computer graphics, and data acquisition systems applications. Key specs include: 210MHz (1.4Vp-p) bandwidth, 640V/µs (2Vp-p) slew rate, 68dB channel crosstalk (30MHz), +6mV/–8mV switching transients, and ±4.6mA (one channel)/±230µA (no channel) quiescent current. Operating from a ±5V supply, MPC102 is available in 14-pin DIPs, SOICs, and dice.

READER SERVICE 291



GAIN	A_1	A_0
1	0	0
10	0	1
100	1	0

New "Easy-to-Use" Programmable-Gain Amplifier

PGA103 is a monolithic digitally programmable amplifier available in an 8-pin plastic DIP and SO-8 surface mount packages. Gains of 1, 10, and 100 are digitally selected by two TTL- or CMOS-compatible control lines. It's an "easy-to-use" simple solution for systems that handle wide dynamic range signals. PGA103's precision, versatility, size, and low cost make it ideal for process control, medical instrumentation, test/measurement equipment, and general-purpose analog boards. Dice also available.

READER SERVICE 292

ew

al, Isolated, Bi-Directional Digital Coupler

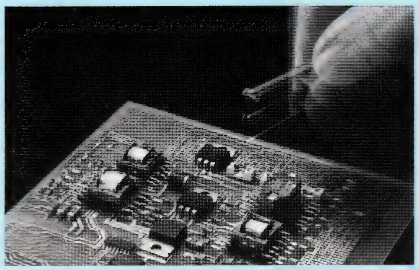
50 is an ultra high-speed capacitively coupled digital device that provides high isolation with very low power consumption. Designed to replace optocouplers, its low power, high d, and low cost make it a reliable alternative. Use it for A/D and D/A conversion, multiplexed data transmission, computer-to-peripheral interfaces, I/O port isolation in instruments, er inversion, and isolated data acquisition systems. Key specs are: 80M Baud typ data rate, TTL/CMOS compatibility, 25mW max power consumption per channel, tested at Vrms isolated partial discharge per VDE0884, and 16.5mm creepage distance. Available in 24-pin single-wide plastic DIP.

READER SERVICE 293

BURR-BROWN®

International Subsidiary Offices: Austria (43) 1 602 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 3465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

FUSES COME PRE-INSTALLED IN SURFACE-MOUNT BLOCKS



The NANO2 Very Fast-Acting or Slo-Blo SMF fuses are now available pre-installed in the SMF Omni-Blok surface-mount fuse block as well as in direct-board-mounting versions. In applications that need frequent replacements, the SMF Omni-Blok makes it easy to change the fuse without subjecting the pc board to the heat of soldering. Because the fuse is pre-installed, the SMF Omni-Blok can be placed on the pc board in one manufacturing operation. The block is available on 16-mm tape in ratings of 1/6 to 7 A. The direct-mount NANO2 SMF Very Fast-Acting fuse is available on 12-mm tape in 1/6- to 15-A ratings. The Slo-Blo version comes on 12-mm tape in 1- to 5-A ratings. The devices and certified by CSA.

***Littelfuse Inc.**, 800 E. Northwest Hwy., Des Plaines, IL 60016; (708) 824-1188.*

CIRCLE 709

Booth 2229

tributors, regulations, taxes and tariffs, international sales representation, cultural and social issues, investment opportunities and international market expansion, and the benefits of NAFTA to the electronics industry and the U.S.

Among the speakers will be Charles K. Alexander, IEEE vice president for professional activities and chairman of the United States Activity Board, and Dick Iverson, president and c.e.o. of the American Electronics Association. The conference will be held on Tuesday of show week from 9:00 A.M. to 5:00 P.M. at the Anaheim Marriott (adjacent to the convention center). Registration for the NAFTA Trading Conference is $45, but that includes admission to the Wescon keynote luncheon, which costs $35.

The keynote address will be given by Michael J. Attardo, IBM senior vice president and general manager of IBM's Microelectronics Division. The address, "The Growing Popularity of RISC," will explain the advantages of this microprocessor architecture compared with CISC devices. In addition, Attardo will discuss new opportuni-

MESSE MÜNCHEN INTERNATIONAL

electronica 94

The standard

electronica 94 is the international electronics forum for the sectors
- Components
- Assemblies
- Electronics Design
- Measurement Technology and Test Systems

Munich, November 8–12, 1994

16th International Trade Fair for Components and Assemblies in Electronics

For developers, decision-makers and users, electronica 94 is a vital catalyst for developments in science and technology.

Further information from:
Messe München GmbH, Messegelände,
D-80325 München,
Tel. (+49 89) 5107-0,
Fax (+49 89) 5107-312

READER SERVICE 120

ties for vendors in areas such as embedded controllers, personal computers, and workstations.

He notes that customers—especially in the data processing, consumer, and communications fields—want higher performance at an attractive price. Traditional technologies, however, are already pushed to the limit when it comes to meeting these demands. As a result, the market for RISC-based microprocessors will expand dramatically in the next few years, according to Attardo.

"RISC technology runs faster, cooler, and occupies less space than CISC," he notes. "Even staunch supporters of the X86 architecture are now publicly indicating that RISC is the future direction for computing and microprocessor needs." ☐

HOW VALUABLE?	**CIRCLE**
HIGHLY	543
MODERATELY	544
SLIGHTLY	545

SOLID-STATE BATTERIES OFFER LIGHT WEIGHT, LONG LIFE

A solid-state, intercalation-based rechargeable battery system produces a lightweight battery with high energy and long life. The batteries will compete with nickel-cadmium and nickel-metal-hydride units for use in cellular phones, laptop computers, military communications equipment, and other wireless products. In an intercalation system, only ions (in this case lithium ions) move between electrodes. The result is a life of more than 1000 charge cycles with minimal loss of capacity. Self-discharge is less than 5% per month. Also, the use of a solid-state electrolyte made of solid polymers offers greater stability and eliminates the need for a metal housing, simplifying production and reducing cost. The resulting increase in energy density means that a 2-oz. battery will power a cellular phone for nearly two hours. The batteries have a projected cost of $0.001 per watt-hour.

Ultralife Batteries Inc.*, 1350 Route 88 S., Newark, NY 14513; (315) 332-7100.*

CIRCLE 710

Booth 3259

"Surely...
we have a better option than **these!**"

Yes, you do.

Turn your
excess inventory
into a tax break and
help send needy
kids to college.

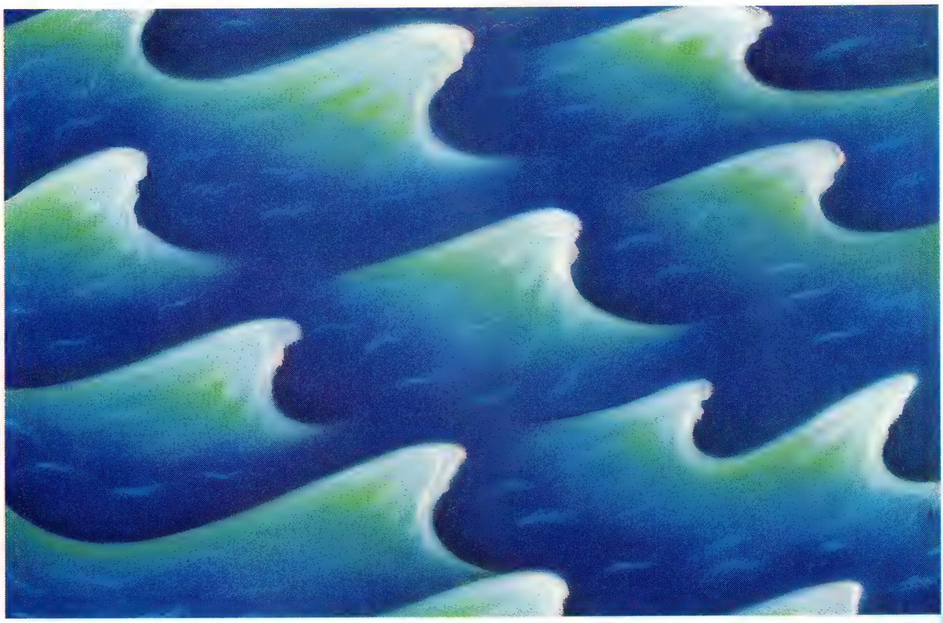
Call for your
free guide to
learn how donating your
slow moving inventory can
mean a generous
TAX WRITE OFF
for your company.

Call (708) 690-0010

EAL

P. O. Box 3021 Glen Ellyn, IL
60138 Fax (708) 690-0565

Excess inventory today....student opportunity tomorrow



NOT THE SAME OLD WAVE

The World's Fastest Monolithic 16-bit Delta-Sigma ADC

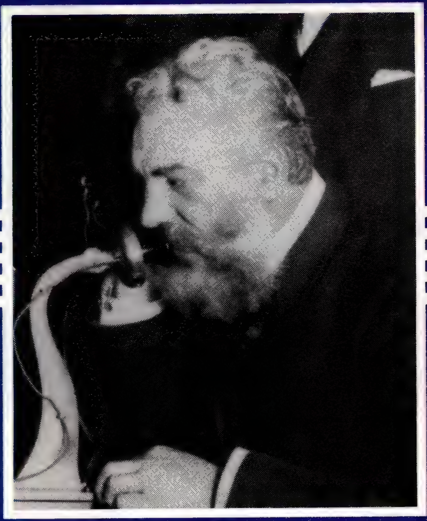
~ 192K Samples Per Second ~

National Semiconductor

The ADC16071/471 ~ DSP-compatible ~ Sampling rate of 192K samples per second ~ THD <0.003% at 1KHz ~ No phase distortion ~ Signal-to-noise + distortion ratio >85dB ~ Internal 64X oversampling ~ Single +5V supply power dissipation of 500 mW ~ Standby power dissipation of 1.0 mW ~ For a free product sample kit and ordering information, call **1-800-NAT-SEMI, Extension 309.**

©1994 National Semiconductor Corporation. NORTH AMERICA: P.O. Box 7643, Mt. Prospect, IL 60056-7643 (Tel: 1-800-628-7364, Ext. 309 Fax: 1-800-888-5113). All rights reserved.

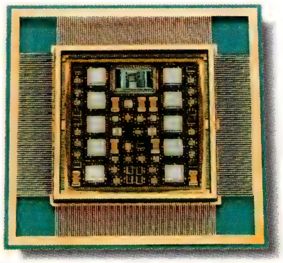
YOU DON'T HAVE TO BE



TO KNOW WHO TO CALL FOR MULTICHIP MODULES.

If Alexander Graham Bell needed MCMs built to his specs, he'd call Raytheon. Because our Multichip Modules are the perfect choice for high-end commercial applications.

You'll find Raytheon high-reliability microelectronics in cardiac implants, satellite communications systems, ground-based radar systems and advanced transportation systems. No wonder designers choose Raytheon MCMs: we give you total systems solutions in a single package. And we can build MCM-D, MCM-C, MCM-C/D or MCM-L using off-the shelf die or ASICs. So when your digital, microwave or mixed signal application demands higher circuit density, greater speed and functionality than traditional technologies, why settle for less than a Raytheon MCM?



High-density MCM-D (2.05 in. x 2.18 in.) supports up to 100 MHz clock frequency.

Best of all, Raytheon know-how is right at your fingertips. We're only a phone call away. So use Bell's invention to put Raytheon's ingenuity to work for you. It could be the smartest call you ever make.

Call (617) 984-4104 or FAX (617) 984-8515 or write for technical support and applications assistance: Raytheon Company, Quincy Operation, 465 Centre St., Quincy, MA 02169.

Raytheon

WE THRIVE ON CHALLENGES

READER SERVICE 180

COURTESY: NCR, ADAPTEC, AND FUTURE DOMAIN

SMART CONTROLLERS SPEED DATA MOVES, TRIM OVERHEADS

DAVE BURSKY

ENHANCED IDE AND SCSI CONTROLLERS IMPROVE SYSTEM THROUGHPUTS WITH MORE INTELLIGENCE, FASTER DATA RATES, AND NEW FEATURES.

High-capacity small-format disk drives have evolved as an essential part of every desktop and portable computer system, as well as a key building block in network file servers and high-reliability RAID (redundant array of independent disks) subsystems. However, although the disk drives are generally able to keep pace with the capacity demands, they're starting to lag behind in data-transfer rates. This performance gap is becoming quite apparent as more graphics and multimedia applications come on line. Makers of disk-controller ICs are responding to the call with new generations of chips that not only accelerate the process of data transfers, but also add new features to simplify the systems.

The new capacity and speed demands come about because many of the latest workstations and servers require tens to hundreds of gigabytes of local mass storage to handle large design files and complex applications that run on multitasking operating systems (e.g., Unix, OS/2, and others). Moreover, there's been a tremendous growth in file size—both executable files and data files—and in the use of graphics-intensive user interfaces and multimedia (audio, video, and animation). Consequently, the drive-control interface's data rate is one of the main performance-determining factors when it comes to the overall system throughput *(Fig. 1)*.

The majority of upcoming improvements in faster and more feature-rich disk-interface controllers are occurring in the two most popular disk interfaces: the integrated drive electronics (IDE) interface (also referred to as the AT attachment or ATA interface) and the Small Computer Systems Interface

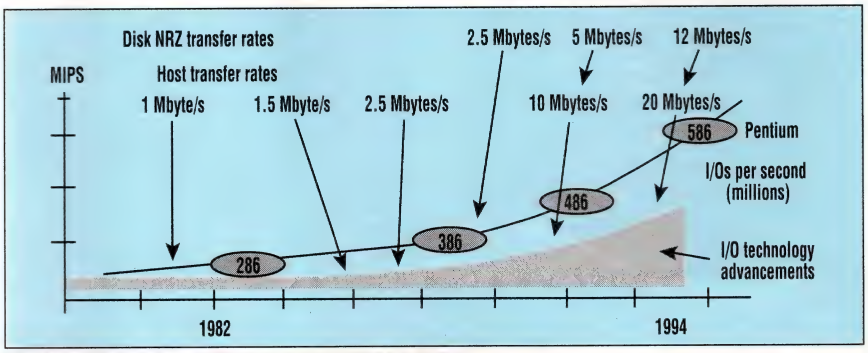
(SCSI). In addition, serial interfaces are now appearing, offering alternatives in systems that need high-performance drives and storage subsystems. However, this report will deal specifically with parallel-I/O storage controllers. A follow-up report will cover serial interfaces.

The IDE-compatible interface has been popular in the IBM-compatible PC world, and now is migrating to other computers. Apple Computer, for example, introduced just two months ago both portable and desktop systems that include IDE interfaces to support a single internal IDE drive.

The IDE interface actually resulted from the embedding of the disk controller used with the original ST-506 drive interface into the disk drive. Integrating all of the control circuitry into the disk drive allowed chip and drive suppliers to dramatically simplify the system-to-drive interface down to a 40-line flat cable. They were able to embed whatever remaining circuitry was needed (decoders and a data interface) as part of a multifunction I/O control chip for the host system.

One example of host-side integration can be seen in the VT82C496G, a highly integrated motherboard chip for 486-based green PCs recently released by VIA Technologies. It includes a local-bus IDE controller that performs 32-bit data transfers using the recently defined Mode 3 scheme, which boosts the transfer speed to more than 10 Mbytes/s (more about the new modes later in the article). The host-side IDE interface includes prefetch and write buffers, which allow concurrent CPU/VESA local-bus and IDE operation to further enhance performance. Either the primary (1F0-1F7h) or secondary (170-177h) channel supports two devices that can be either hard-disk drives, or IDE-based CD-ROM or tape drives. The controller also contains programmable read/write, master/slave, and active/recovery timing in units of the CPU clock frequency.

Other examples of host-side integration include the Adaptec AIC-8370, 7165 and 71LV66; the Cirrus Logic CL-SH5600 and 4600; the Silicon Systems 9600 series; and the Western Digital WD61C42A. These ICs simply the read channel, a microprocessor and/or a DSP chip, and some buffer memory to perform all of the drive control *(see "Controlling the inner workings," p. 88)*. In addition to the host ATA interface, these chips typically include error detection and correction, performing either cyclic redundancy checking (CRC) or Reed-Solomon (R-S) error checking and correction *(Fig. 2)*.



1. AS HOST CPU PERFORMANCE **improves, storage peripherals must transfer data at higher rates. The growth, as shown in this graph from Adaptec, is nonlinear. That's because in addition to faster operating speeds, data-bus widths also have increased, demanding host burst-transfer rates of 20 Mbytes/s and higher. To maximize host transfer rates, the data rate in the read-channel must increase to ensure the internal buffer doesn't starve the interface.**

In Western Digital's controller, the data-protection subsection can correct single burst errors of 17 bits (guaranteed), and even correct up to 72-bit errors on-the-fly using on-chip microcode. A slightly different but similar combination of CRC and R-S is used in Cirrus Logic's CL-SH5600. Both chips employ programmable sequencers that allow drive designers to specify the disk formatting, optimizing the data storage format to the media type (soft-sectored or embedded servo, for example).

First-generation IDE (referred to as ATA-1) interfaces are inexpensive, offering system manufacturers a system connection cost of less than $1.00. Moreover, there are no termination hassles, a single jumper sets the master/slave operation of the two drives, the controller has a single register set and one command set, and support is included in every system BIOS.

However, these interfaces only deliver maximum throughputs of about 8.33 Mbytes/s using the Mode 2 parallel-I/O (PIO) AT-bus transfer option, a rate that's limited by the host system bus, not the drive. For many forthcoming applications, that's not fast enough. There also are other limitations. IDE has a BIOS-imposed barrier of 528 Mbytes for the drive capacity (special drivers can often eliminate this limitation, but those drivers take up valuable memory space). Furthermore, IDE is specific to hard-disk drives and can't be used to control other storage devices (CD ROMs, tape drives, etc.). On top of that, IDE's 40-pin connector/cable allows only two devices to be attached.

To improve IDE, many companies have worked together to define a new and enhanced IDE interface—ATA-2—which employs the Mode-3 or Mode-4 PIO options. PIO Mode 3 is the typical implementation in BIOS for both the VESA local bus (VL-Bus) and the peripheral-component interconnect (PCI) bus. With Mode 3, data-transfer rates can increase to about 11.1 Mbytes/s (13.3 Mbytes/s with multiword DMA transfers), while Mode-4 operation boosts the data-transfer rate to about 16.6 Mbytes/s. Still in the definition stage is ATA-3, which will offer even faster data transfer rates and additional features.

With such speeds, IDE drives will be able to compete nicely with the Fast SCSI drives in mid-range desktop and high-performance portable systems. But these improved data-transfer rates will go for naught if the IDE interface feeds into an AT bus. Higher-performance bus interfaces like the VL-Bus or the PCI bus

Proceedings of Portable By Design

Sponsored By Electronic Design Magazine

Price $150.00 per copy (add $12.00 shipping & handling per copy)

A conference for OEM Designers of portable, nomadic, mobile, transportable and hand-held products. The product areas covered in these proceedings include almost 800 pages of information on:

* Power Circuits
* Connectivity
* Input Devices
* Managing Mechanical/Electrical Design Teams
* Expandability/Configurability
* Engineering The Whole System
* High End Microprocessors
* Low-Power Microncontrollers
* Power Management
* Application Development & Operating Systems
* Batteries
* Displays

For additional or ordering information, please call (201) 393-6075

offer more than quadruple the bandwidth of the basic AT bus.

However, with the higher data rates comes a potential noise problem on the cables, according to Jim McGrath, a systems engineer at Quantum Corp., Milpitas, Calif. The noise problem, he explains, is partially a result of the poor design and definition of the IDE 40-pin interface—there aren't enough ground lines and the bus isn't terminated. Such a combination is lethal to signals on long cable runs. One solution proposed by Western Digital recommends the IDE cable length be limited to 18 in. and include series resistors on the signal lines at the host side.

In another major upgrade, designers figured out how to use the Interrupt 13h (hex) signal as a BIOS trans-

CONTROLLING THE INNER WORKINGS

Disk drives typically contain an interface controller (a dedicated chip with a command interpreter and state machine or RISC engine to respond to external requests) as well as a second processor or two that control the inner workings. For example, many disk drives employ 8- and some 16-bit microcontrollers to perform the computations that position the read/write heads and control the motor speed. As the drive capacity increases, the data tracks on the disk are packed closer together. That means head positioning must be even more precise.

Now comes the challenge. As the positioning needs become more precise, more complex algorithms are required to accurately compute the position. At the same time, drive manufacturers try to improve the drive access time by positioning the head faster, which is in direct conflict with the need to be more precise.

The solution: Improve the speed of the critical computations by moving them to a digital signal processor, either in the form of a standalone chip or as a capability embedded in a more-complex microcontroller. Drive manufacturers and MCU suppliers have gone in both directions, as well as a third—design a DSP chip that performs both the positioning computations as well as the generic control functions, effectively eliminating the MCU altogether.

Depending on the computational throughput and the cost constraints of the end product, all three approaches are viable. However, most disk-drive manufacturers have settled on adding some high-level compute capabilities to the MCU as the first-generation approach to internal drive control.

Vendors such as Zilog, Hitachi, Mitsubishi, Motorola, and many others have MCUs optimized for disk control. Such MCUs typically include some analog-to-digital or digital-to-analog converters that can be used for spindle and head-positioning control, and some dedicated DSP resources like a fast multiplication instruction or an actual digital-signal-processor megacell. Dedicated circuits for servo control, spindle-motor speed control, and other internal functions (e.g., analog read channel) are usually standalone chips or implemented with discrete components.

Zilog's Z86C95, one of the first chips to merge an 8-bit MCU and the DSP function, was introduced about two years ago. In addition to the Z8 MCU core, the chip includes a DSP megacell with a hardware 16-bit multiplier that can perform single-cycle 16-bit multiply-accumulates. A second hardware 16-bit multiplier that can perform 32-bit/16-bit division also is incorporated. Other resources include three 16-bit counter-timers, a half-flash 8-bit eight-channel ADC with a 2-µs conversion time, an 8-bit DAC with a 1/4-programmable gain stage, a UART and a simple synchronous serial port, and a pulse-width-modulated output channel.

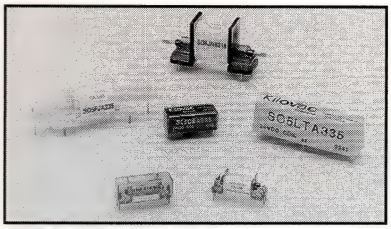
Having had two years of experience with the Z86C95, designers at Zilog upped the ante by creating the Z86C295, a higher-performance version unveiled earlier this year. They enhanced the DSP megacell and increased the chip's level of integration by incorporating the servo timer function so that the chip can better handle the servo loop for head positioning.

Dedicated DSP chips, such as the TMS320 family from Texas Instruments, also have found their way into disk drives, often used along with an 8-bit MCU. However, the small profit margin that drive manufacturers are forced to live with pushes them to further integrate the circuitry to reduce cost. Another factor influencing integration is the smaller form factor of the drive, which has gone from 5.25- to 3.5- to 2.5- and now to 1.8-in. diameters. As a result, available board space for the control logic is reduced to just a couple of square inches.

Although the popular approach taken by Zilog has been followed by other companies, 8-bit MCUs are limited when it comes to housekeeping tasks, which are becoming more complex. Thus, designers at Maxtor and Texas Instruments decided to explore the use of a single, 16-bit streamlined DSP core that would serve as both the computational block and as the housekeeping controller. Their efforts culminated in a custom chip that Maxtor employs in its latest 1.8-in. PCMCIA-compatible 171-Mbyte disk drive, and a megacell DSP core offered by TI in its design library for customer-specific DSP ICs *(see "DSP-based PCMCIA drive packs 171 Mbytes," Sept. 5, p. 135)*.

Other companies have taken note and begun to employ such an approach. The Pine and Oak DSP cores developed by The DSP Group are some of the first candidates for expansion as a combination DSP/controller for disk drives. Those cores were selected because they're very area-efficient and result in low-cost chips that suit the drive-cost model very well.

Advertisement

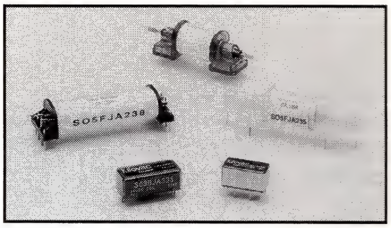


High Voltage Reed Relays
Are small and lightweight. Kilovac's new S Series high voltage reed relays offers over 20 models with voltage isolation from 300 to 15,000 volts. Ideal for a wide variety of high voltage applications, these compact devices are configured to handle everything from load switching to the rigors of high-power RF circuits. Prices start at just $12.10 each in 100-piece quantities with delivery from stock. Kilovac Corporation, Santa Barbara, CA., phone 805-684-4560, fax 805-684-9679.

READER SERVICE 248

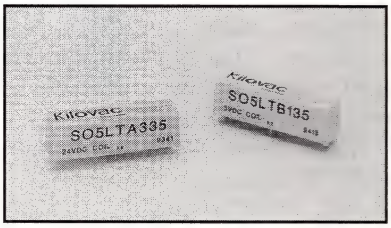
Multi-Pole HV Reed Relays
Offer design flexibility and space savings. Double-pole single-throw (DPST) reed relays are now available for immediate delivery from Kilovac. These relays offer the ability to switch different circuits with a single signal to a single coil. One model combines a normally open, form A switch with a normally closed, form B switch providing "on/off" flexibility. Voltage ratings are up to 5 kVdc. Prices for 100 pieces start as low as $25.22 each and all models are available from stock. Kilovac Corporation, Santa Barbara, CA., phone 805-684-4560, fax 805-684-9679.

READER SERVICE 249



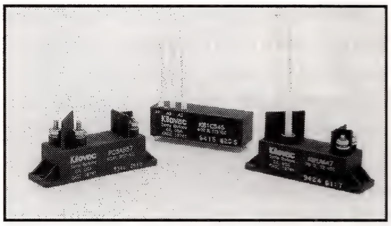
RF Power HV Reed Relays
Provide high isolation and low insertion loss. Kilovac Corporation now offers RF reed relays that will handle up to 6 amps at 30 MHz. These highly reliable reed relays are rated up to 8 kV with isolation values greater than 45 dB at 30 MHz and insertion loss of less than 0.06 dB at 30 MHz. RF screens are incorporated into the relays to eliminate proximity effects where relays need to be mounted close to each other or close to the other inductive components. All models are available from stock for immediate delivery. Prices at 100 pieces range from $12 to $53 each. Kilovac Corporation, Santa Barbara, CA., 805-684-4560, fax 805-684-9679.

READER SERVICE 250



Power Switching HV Reed Relays
Compact package will switch 500 watts. Kilovac's S05L Series high voltage reed relays provide voltage isolation of up to 15 kV. Ideal for test and measurement equipment or other applications that require power (load) switching, these relays have contacts capable of carrying up to 5 amps continuously while switching as much as 500 watts. Standard coil voltages of 5, 12, or 24 Vdc require as little as 26 milliamps to operate (24 Vdc coil). Prices start at $26.40 each in 100-piece quantities and are available from stock for immediate delivery. Kilovac Corporation, Santa Barbara, CA., phone 805-684-4560, fax 805-684-9679.

READER SERVICE 251

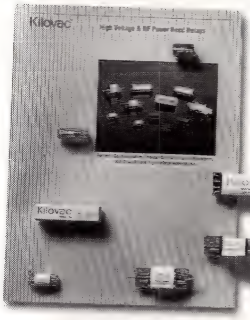


High Voltage, High Power Vacuum Relays
Packaging flexibility and extended power handling. Kilovac Corporation has expanded their compact K81 Series relays to include panel mount and power switching models. Today's best-selling 10 kV relay is now available in a panel mount configuration with stud terminals or flying leads providing added versatility. The new panel mount models compliment the K81 line that includes all PC pin and PC pin plus flying lead models. All K81 relays are vacuum-sealed and can operate in explosive or harsh environments. Kilovac Corporation, Santa Barbara, CA., phone 805-684-4560, fax 805-684-9679.

READER SERVICE 252

Avoid Monstrous High Voltage Control Problems...

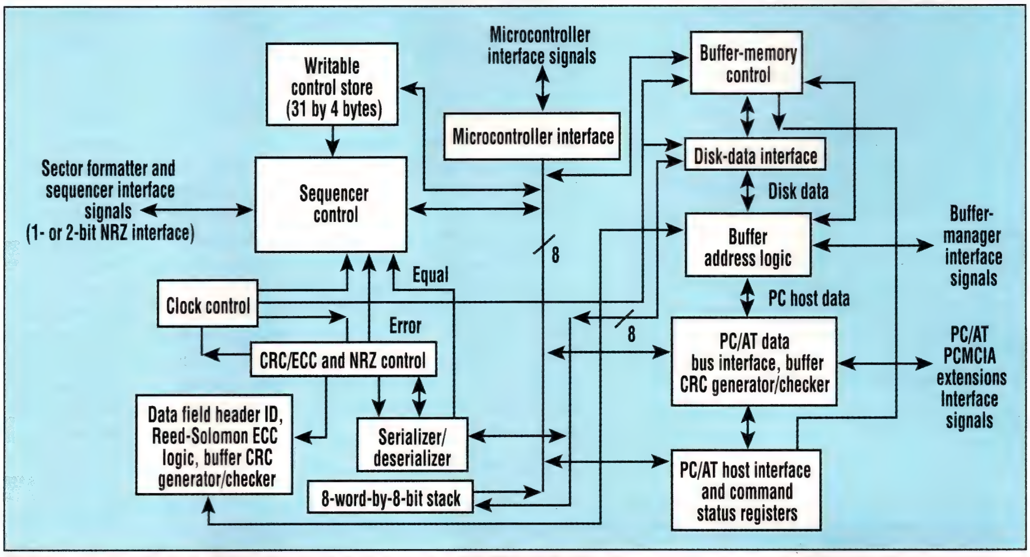
Insist On Kilovac High Voltage Relays And DC Contactors.
Whether your power control applications call for 28 V or 70,000 V, isolation or power switching, you can rely on Kilovac, the expert in designing, engineering and manufacturing high voltage relays and DC power switching devices.
Write or call Kilovac for complete product literature or to discuss your specific high voltage applications.



Kilovac®

APPLICATION HOTLINE: 800-253-4560
P.O. BOX 4422 • SANTA BARBARA, CA 93140 • 805-684-4560 FAX 805-684-9679

READER SERVICE 278


Writable control store (31 by 4 bytes)
Microcontroller interface signals
Buffer-memory control
Microcontroller interface
Disk-data interface
Disk data
Sector formatter and sequencer interface signals (1- or 2-bit NRZ interface)
Sequencer control
8
Buffer address logic
Buffer-manager interface signals
Equal
PC host data
Clock control
Error
8
PC/AT data bus interface, buffer CRC generator/checker
PC/AT PCMCIA extensions Interface signals
CRC/ECC and NRZ control
Data field header ID, Reed-Solomon ECC logic, buffer CRC generator/checker
Serializer/ deserializer
8-word-by-8-bit stack
PC/AT host interface and command status registers

2. ALL MAJOR DATA-RELATED FUNCTIONS within an IDE disk drive can be performed Cirrus Logic's CL-SH5600. The chip is representative of available embedded IDE controllers, some of which differ in the size of the buffer memory they support and the programmability of the sequencer control.

lation signal in the short term so that drives with capacities of up to 8.4 Gbytes can be addressed. A longer-term solution will extend the Interrupt 13h signal and allow for up to 2^{64} blocks per drive.

Another improvement involves the use of a second cable that permits two additional drives to be attached, allowing an IDE adapter to support four drives. In a typical scenario, the primary interface would support 9 to 13 Mbytes/s, while the secondary IDE port might support slower devices such as tape, CD-ROM drives, and other removable media types.

A key factor impacting this enhancement is the creation of a specification that makes it possible to attach the CD-ROM or tape drive—the ATA Packet Interface (ATAPI) specification/definition that will be part of ATA-3. Originally proposed by Western Digital, the ATAPI working draft was defined by the joint efforts of almost two dozen companies (the final version of the ATAPI working draft is available to designers through the small form-factor committee).

The ATAPI specification proposal allows for a single, standard device driver that would be embedded in the operating system. That driver would implement the packet communications interface over the IDE connector. Under the proposal, ATAPI uses the ATA interface protocol with an eight-register task file and a master/slave connection scheme. Added to that is a Packet command—a 12-byte command packet that's sent to the command register. The command packet actually derives from the SCSI standard, so there's some commonality of structure. However, ATAPI doesn't use the SCSI protocol (no phases, messages, disconnect/reconnect, linking, or queuing).

Because ATAPI's main function is to support CD-ROM drives, the command set includes a few new features optimized for reading standard and photo CDs. New commands include the Packet command, an Identify Device command to obtain parameter data (similar to the ATA Identify Drive command), and the Soft Reset command, which resets an individual device, not the entire channel. And, because ATAPI employs a subset of the SCSI commands, existing SCSI software should be able to be retargeted very quickly.

Few circuits, though, are available yet to support the ATA-2 and ATA-3 (ATAPI) enhanced IDE interfaces. Still, many companies are hard at work developing some solutions. One such company, Silicon Systems, recently released the SSI9600, a controller that supports ATA-2 operation at up to 11.1 Mbytes/s in the PIO mode and 13.3 Mbytes/s using the DMA option.

Although the chip was created for desktop systems, it includes several power-management features that will trim drive power drain, easing the design of "green" systems. In addition, Silicon Systems is working on an ATAPI-compatible controller it hopes to release late this year.

Designers at NCR also are focusing on enhanced IDE controllers, readying what they expect to be the first bus-mastering IDE control chip with DMA support. Although silicon will be fabricated this month, the company won't release the chip until the supporting software drivers are prepared. Similarly, QLogic developed the ATEC336, a highly integrated controller that implements the enhanced ATA-2 feature set and includes a 16-bit DMA controller.

Due to its involvement in developing the ATAPI definition, Oak Technology is already shipping its OTI-011 ATAPI controller to a number of CD-ROM manufacturers that have recently released drives to the market. The chip supports the Sony-Phil-

INFORMATION RESOURCES

The following resources will provide additional information on disk controllers and related issues:

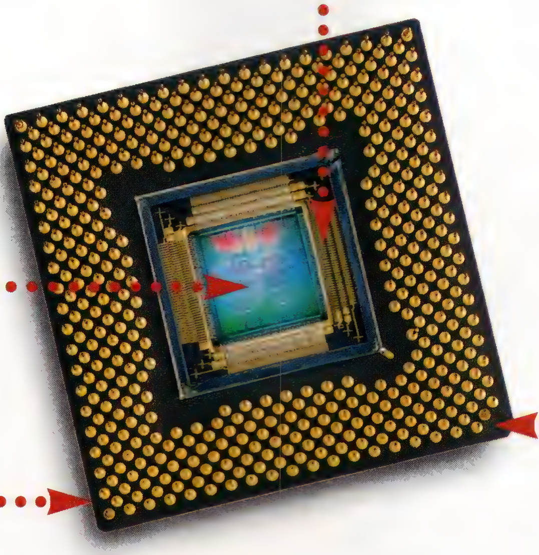
- *Information Resources (Faxback service),* (408) 741-1600.
- *Technology Forums Inc.* and the RAID advisory board, 13 Marie Ln., St. Peter, Minn., 56082-9423. Contact Joe Molina at (507) 931-0967.
- *The Fast ATA Source Book.* Contact Tim Sutton at Seagate Technology, Scotts Valley, Calif., (408) 439-2880.
- *The X3T10 Standards Committee* for SCSI and ATA activities, John Lohmeyer, Chairman, NCR Corp., Colorado Springs, Colo.; (719) 596-5795.

BIG I/O

504 I/O pads, arranged in
two rows around the periphery
of the chip.

BIG DIE

.560 inches square, embedded
emory, and over 100,000 gates.
very big die.



BIG HEAT

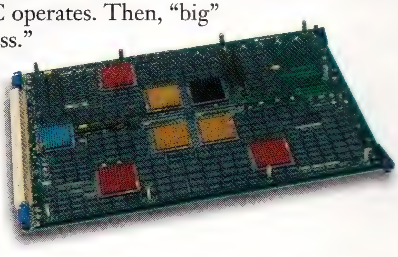
Running at 20 MHz and generating eight watts of power. With this much power, we had to pipeline the heat away from the die.

BIG PACKAGE

The only off-the-shelf package that met all the technical specifications was three to four times too expensive. The solution: a custom ceramic PGA, shown here at actual size.

NO BIG DEAL

"Big" does **not** have to equate to "big deal." As in problems. As in endless delays. As in unforeseen costs. Not when you have an ASIC vendor that understands the system-level context in which an ASIC operates. Then, "big" can lead to "big success."



That's what IKOS Systems found out recently, when they brought the custom gate array you see above to American Microsystems, Inc. To create their next-generation hardware accelerator for logic simulation, IKOS needed to embody their evaluation algorithms in four ASIC designs with over 300,000 gates of custom logic in all.

If AMI were the kind of ASIC vendor who thinks their responsibility ends at the netlist, this project could have been a very big deal–and a very big headache–for IKOS Systems.

Instead, AMI worked with IKOS Systems and a qualified package vendor to design a custom ceramic pin grid array that met all of the extensive physical, electrical and thermal constraints represented by a gate array of this complexity.

We thought the IKOS System development was a big challenge, to be sure, and we're glad that for our customer, it was a big success. But, with over a quarter-century of ASIC experience, meeting big challenges and creating big successes for our customers is never a "big deal."

So the next time you're faced with that potentially "big deal" development, come to the ASIC vendor that can help you knock it down to size–AMI.

For a free case study of the IKOS Systems development, jointly authored by AMI and IKOS Systems, or for additional information about AMI's products and capabilities, call 1-800-NEWS-AMI today (1-800-639-7264).

See us at Booth #3253 at Wescon & idea/Microelectronics '94
September 27-29, Anaheim Convention Center, Anaheim, CA.

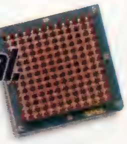
Corporate Headquarters:
American Microsystems, Inc.
2300 Buckskin Road
Pocatello, Idaho 83201
(208) 234-4690
(208) 234-6795 (FAX)

AMI-GmbH
St. Petersburger Str. 15
D-01069 Dresden, Germany
[-49]-(0) 351-487-3353
[-49]-(0) 351-487-3313 (FAX)

DOCUMENTED
ISO 9001
EXCELLENCE
CERTIFIED

AMI®
SEMICONDUCTORS
American Microsystems, Inc.

Big ASICs. No Big Deal.



Copyright 1994, American Microsystems, Inc. All rights reserved.

11
12
1
2
3
4
5
6
7
20
TWENTY DOLL
JACKSON
1000 YEN
86L671893
AD403719
N25 554963
20
nte Francs
1589747
1000
HA7303

Squeeze the most out of your design cycle.

You know time is money. And at Texas Instruments, we can help you speed your product to market. Meaning you are free to do what you do best – create the next breakthrough products.

Be first to market with leading-edge designs. From notebooks and PDAs to wireless communications and multimedia, you can harness the power of TI's DSP solutions, low-power 486 microprocessors and mixed-signal devices to design unique products fast. Our industry-leading TMS320 DSP family offers a road map with the flexibility of software-programmable solutions that can migrate into highly integrated, custom DSPs that deliver cost-effective high performance. And compatible logic families and memory devices also help you move your designs easily from 5 V to 3 V.

Total Integration in action.

Seagate Technology put the power of Total Integration to work when creating their hard disk drives. In addition to combining TI's high-performance DSP cores and application-specific logic with memory and analog cells, TI had the tools and service to help Seagate produce a highly differentiated product. And TI's on-time delivery made a difference. TI provides high-volume, quick-ramp manufacturing capability to meet Seagate's needs as an industry leader.

Technical support that gets you up to speed, fast. Move quickly from selection to prototype with clear, concise technical information and real-world application notes. And C compilers, emulators, development tools, behavioral models and SPICE rules can help you create DSP solutions in record time.

Setting the benchmark: A 94% on-time delivery record. At TI, we deliver what we promise. So you won't be left waiting for your ICs to arrive. In fact, in an expanding market, we set an industry benchmark by having a 94% on-time-to-commit-date delivery record.

Win the race to market. Getting to market faster with a better product. That's what business is all about. And with TI, you'll find a unique blend of silicon, support and service. We call it Total Integration.™ You'll call it your competitive edge. To find out more, just call your nearest TI sales office listed below.

EXTENDING YOUR REACH™

TEXAS INSTRUMENTS

Australia & New Zealand: Sydney, 61-2-910-3100, fax 61-2-805-1186; Melbourne, 61-3-696-1211, fax 61-3-696-4446. **Hong Kong:** 852-737-0338, fax 852-735-4954. **India:** 91-226-9007, fax 91-226-7849. **Korea:** 82-2-551-2804, fax 82-2-551-2828. **Malaysia, Indonesia and Thailand:** 60-3-208-6001, fax 60-3-230-6605. **People's Republic of China:** 86-1-500-2255, ext. 3750, fax 86-1-500-2705. **Philippines:** 63-2-817-6031, fax 63-2-817-6096. **Singapore:** 65-390-7100, fax 65-390-7062. **Taiwan:** 886-2-377-1450, fax 886-2-377-2718.

© 1994 TI

00-8601ae

READER SERVICE 134

ips CD-ROM, CD-ROM/XA, and CD-I formats, and can interface directly to IDE buses without data buffers or decoders, delivering bursts of up to 8 Mbytes/s. Included are the CD-ROM data descrambler, a real-time error corrector, and host interface logic.

Designed for use with a companion 8-bit microcontroller, some DRAM or SRAM, and standard DSP chips, the OTI-011 can support disk speeds of 1, 2, 3, or 4X. Once data is passed to the controller from the DSP portion of the drive, the real-time ECC logic corrects one error per P-word and Q-word. Repeated ECC passes also can be done without disabling the DSP buffering, ensuring data integrity without compromising speed.

The control circuits that go inside the drive certainly are crucial, but the I/O control circuits that go on the cards that plug into the AT, VL-Bus, or PCI buses are just as essential for top end-to-end performance. One of the latest host-side chips that supports IDE is a Super I/O chip developed by National Semiconductor. A local-area-network (LAN) interface is included in the device.

One key support function incorporated into the PC87340VUL chip is an IDE controller with DMA support logic that can address two drives and transfer data at the 11.1-Mbyte/s ATA-2 speed. Other on-chip functions include a phase-locked loop for stable system timing, a 6-kbyte SRAM-based buffer to support the 10Base-T Ethernet controller, a floppy-disk controller with an analog data separator, a pair of buffered UARTs (16550-compatible), and an IEEE-compatible enhanced-communication-protocol (ECP) parallel port.

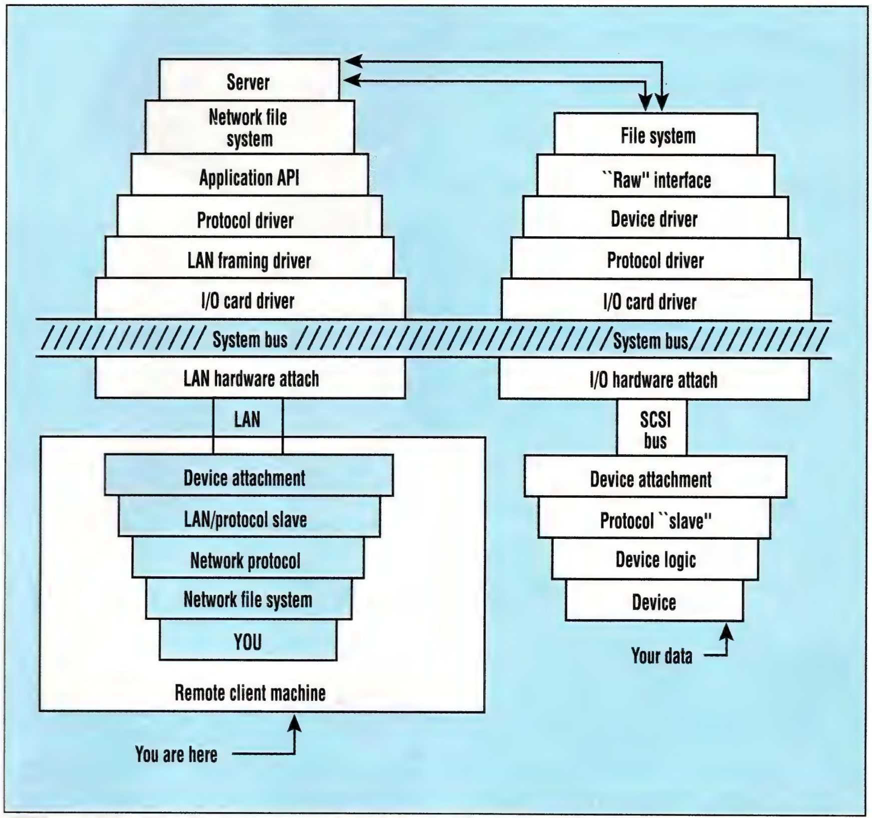
Although it controls CD-ROM drives, a unique chip from Symphony Laboratories and Omega Micro can't be classified as either an IDE or SCSI controller. The SL82C201 was designed to interface to and control non-SCSI CD-ROM drives that typically require proprietary interface cards. Thus, drives from Mitsumi, Panasonic, Philips, and Sony can operate in a system transparently to the CD-ROM device driver supplied by the drive manufacturer. The chip can be configured for either PIO or DMA transfer modes, and permits either software or hardware to set the I/O port address, the interrupt, and the DMA channel.

Supporting the VESA local bus on the host side, the VT83C461 IDE controller designed by VIA Technologies provides a 32-bit-wide data interface to the host system and supports both Mode-3 and Mode-4 data-transfer rates. One unique feature allows up to eight chips to be cascaded for applications that require more than the two drives handled by a single IDE controller. Prefetch and posted-write buffers allow concurrent host-system and drive operation, improving overall system efficiency. The chip also has two operating modes: a Promise PDC20230B/C-compatible mode, and an enhanced mode that supplies more sophisticated handshaking to the IDE drives.

Because the IDE interface is very simple, many companies also are designing custom controllers that incorporate standard, and now enhanced, IDE interfaces. The I/O MAXimizer, recently developed by Gainbery Computer Products Inc., Markham, Ontario, Canada, is one example of how I/O transfer speeds can be maximized.

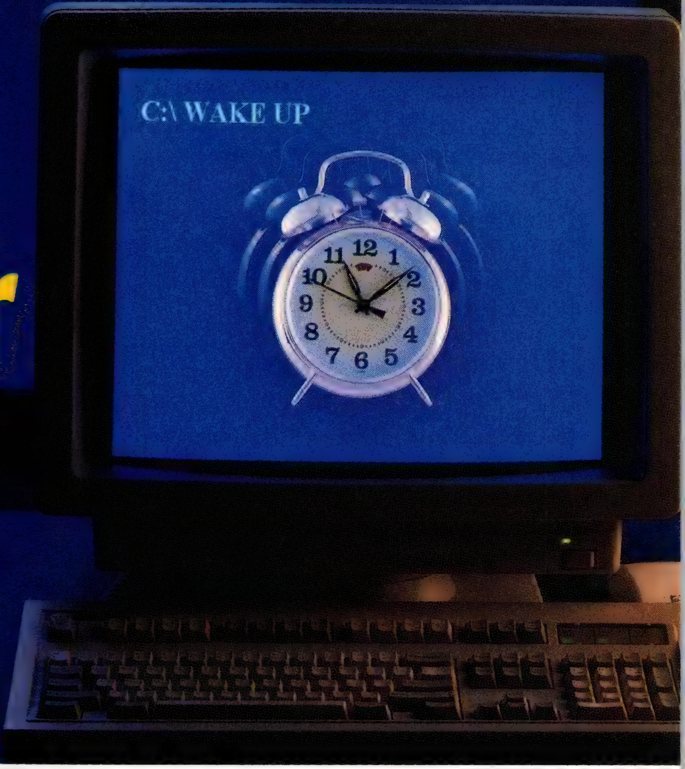
Available with either a PCI or VESA bus interface, the board combines the intelligence of a 68349 32-bit microcontroller from Motorola with a custom chip, the GL3203. Together the two chips implement an intelligent data cache that employs 1 to 12 Mbytes of DRAM. The board's caching scheme can boost I/O data-transfer rates up to the host bus maximum of 132 Mbytes/s and data transfers to the IDE drive's internal buffer at rates of up to 20 Mbytes/s.

For portable systems, the Personal Computer Memory Card Interface Association (PCMCIA) came up with an option mode on the PCMCIA interface: It provides an IDE signal set to control 1.8-in. hard-disk drives. The ATA/IDE interface allows PCMCIA-compatible storage products, both hard-disk drives and solid-state equivalents (typically implemented with nonvolatile flash-style



3. THE HIERARCHY OF HOW A DATA TRANSFER navigates its way through all device-driver layers and interfaces isn't for the faint-hearted, as this access flow from IBM indicates. The most impressive aspect is that it all works, and requests can propagate themselves up and back through the hierarchy in fractions of a second.

Self-Starter



Power Conservation for PC's and Portables

With the DS1587 Serialized Real Time Clock, your computer can turn itself on at a pre-set time, perform a task, and shut itself off. Automatically. With no human intervention.

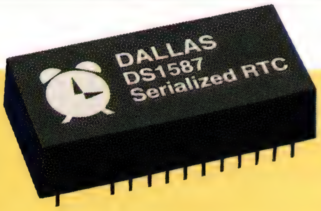
The DS1587 can even be used to establish a time-out program. When a certain amount of time has passed without activity, the system is automatically powered down.

Remote Access: The Ultimate Convenience

The DS1587's kickstart feature opens up new possibilities. For example, with a laptop and a modem, you can call up your desktop PC from halfway around the world, retrieve important files, and then turn the PC off.

Unique Serial Number Assures Absolute Traceability

A 64-bit, guaranteed unique serial number engraved in silicon identifies each computer for a variety of purposes. Like warranty tracking. Or asset management.



Of course, the DS1587 has lots of other unique features (that's why we're known as the world's leader in computer timekeeping chips):

- 114 bytes of user NV RAM and 8K x 8 expanded NV RAM can store system configuration data and personalization information.
- The device's 32 kHz output alleviates the need for an additional oscillator for power management.
- Available as chip (DS1585) or standalone module (DS1587) with embedded lithium and crystal.
- DS1587 operates over 10 years in the absence of external power.

For more information on our large family of timekeepers, give us a call at (214) 450-0448.

DALLAS
SEMICONDUCTOR

4401 South Beltwood Parkway ■ Dallas, Texas 75244-3292 ■ Tel: 214-450-0448 ■ Fax: 214-450-3715

READER SERVICE 167

memory chips), to be plugged in.

To implement the ATA/IDE interface in a PCMCIA format, the appropriate signals on the 68-lead connector are controlled by software and the logic on the PCMCIA control chip. Although the signals match the ATA/IDE interface electrically, the physical format is quite different. In the drive card, chips such as Adaptec's AIC-71LV80/81 integrate most of the control electronics and provide either a PCMCIA 2.0 or ATA interface. The Adaptec chip is specified for operation at either 5 or 3.3 V and can support buffers from 64 kbytes to 1 Mbyte in the card with direct addressing.

A similar chip, the CL-SH380, was released earlier this year by Cirrus Logic. The chip provides a PCMCIA and ATA interface on the host-system port and a read-channel interface to drive the head-disk assembly on the other side. When powered by a 5-V supply, the chip's drive interface can operate at rates of 40 to 44 Mbits/s. When powered by a 3.3-V supply, the drive-interface throughput decreases to between 30 and 40 Mbits/s. Another chip, the SH385, is a more sophisticated version that performs multiple-burst and header-ID on-the-fly error correction.

For the host-system side, Cirrus also offers the CL-PD6710/672X, a family of host adapters that provide direct interfaces from the ISA host bus to PCMCIA sockets. The CL-PD6710 supports a single PCMCIA socket, while the CL-PD6720 and 6722 support two sockets. All versions allow for mixed 3.3- and 5-V operation, which minimizes power drain (50% that of a 5-V only alternative). In addition, they include a Suspend mode that stops the internal clock, and an automatic low-power dynamic mode that stops transactions on the PCMCIA bus, stops internal clock distribution, and turns off many of the internal circuits. A PCI version, the CL-PD6729, has just been released for sampling.

Zilog, also working on a PCMCIA-to-ATA interface chip, came up with the Z86017 intended for PCMCIA cards. On the host side, it provides either the standard PCMCIA 2.0 or ATA/IDE signal set. Such a circuit could be used, for example, with a SCSI control circuit to squeeze a PCMCIA-to-SCSI function into a PCMCIA card. The Z86017 implements the first-generation IDE/ATA interface. But now that the enhanced IDE is starting to hit on the desktop side, Zilog expects to migrate that functionality into its controller by early 1995. Already, an internal slave DMA controller was added to support the higher data-transfer speeds possible on the IDE interface.

Initial speeds of the PCMCIA/IDE interface allow data transfers of about 7.5 Mbytes/s. However, as the PCMCIA interface evolves from its 8/16-bit interface to a full 32-bit bus (referred to as the Card Bus by the PCMCIA standards organization), existing data-transfer rates will at least double. Many companies are working on PCMCIA interface circuits. In fact, Intel, Omega Micro, Symphony Labs, Vadem, VLSI Technology, and several others have or will shortly have circuits for both the host and card sides of the interface.

Impressive as the advances are in the IDE interface, SCSI channels are advancing as well. The current 8-bit Fast (10-Mbyte/s) and 16-bit Fast/wide (20-Mbyte/s) interfaces now are well established. Designers also are striving to implement the next

REPRESENTATIVE SUPPLIERS OF DISK-CONTROL AND INTERFACE CHIPS

Adaptec Inc.
Milpitas, Calif.
(408) 945-8600
CIRCLE 601

Advanced Micro Devices Inc.
Sunnyvale, Calif.
(408) 749-5465
CIRCLE 602

Advansys Inc.
San Jose, Calif.
(408) 383-9400
CIRCLE 603

Applied Micro Circuits Corp.
San Diego, Calif.
(619) 450-9333
CIRCLE 604

Atmel Corp.
San Jose, Calif.
(408) 441-0311
CIRCLE 605

BusLogic Inc.
Irvine, Calif.
(714) 492-9090
CIRCLE 606

Chips and Technologies Inc.
San Jose, Calif.
(408) 434-0600
CIRCLE 607

Cirrus Logic Inc.
Fremont, Calif.
(510) 623-8300
CIRCLE 608

The DSP Group
Santa Clara, Calif.
(408) 986-4315
CIRCLE 609

Fujitsu Microelectronics Inc.
San Jose, Calif.
(408) 922-9000
CIRCLE 610

Future Domain Inc.
Irvine, Calif.
(714) 253-0400
CIRCLE 611

Gainbery Computer Products Inc.
Markham, Ontario, Canada
(905) 415-0480
CIRCLE 612

Hitachi America Ltd.
Brisbane, Calif.
(415) 589-8300
CIRCLE 613

IBM Corp.
Austin, Texas
(512) 823-8208
CIRCLE 614

Intel Corp.
Folsom, Calif.
(916) 356-8080
CIRCLE 615

LSI Logic Inc.
Milpitas, Calif.
(408) 433-8000
CIRCLE 616

Motorola Inc.
Austin, Texas
(512) 928-6000
CIRCLE 617

National Semiconductor Corp.
Santa Clara, Calif.
(408) 721-5000
CIRCLE 618

NCR Corp.
Colorado Springs, Colo.
(719) 596-5795
CIRCLE 619

Oak Technology Inc.
Sunnyvale, Calif.,
(408) 737-0888
CIRCLE 620

Omega Micro Inc.
Sunnyvale, Calif.
(408) 522-8893
CIRCLE 621

OPTi Inc.
Santa Clara, Calif.
(408) 980-8178
CIRCLE 622

Philips Semiconductors
Sunnyvale, Calif.
(408) 921-2000
CIRCLE 623

QLogic Inc.
Irvine, Calif.
(800) 737-6524
CIRCLE 624

Silicon Systems Inc.
Irvine, Calif.
(714) 573-6750
CIRCLE 625

Standard Microsystems Corp.
Hauppauge, N.Y.
(516) 435-6175
CIRCLE 626

Symphony Laboratories
Santa Clara, Calif.
(408) 986-1701
CIRCLE 627

Texas Instruments Inc.
Dallas, Texas
(800) 336-5236
CIRCLE 628

Vadem Corp.
San Jose, Calif.
(408) 943-9301
CIRCLE 629

VIA Technologies Inc.
Fremont, Calif.
(510) 663-3300
CIRCLE 630

Vitesse Semiconductor Corp.
Camarillo, Calif.
(805) 388-7408
CIRCLE 631

VLSI Technology Inc.
San Jose, Calif.
(408) 434-3100
CIRCLE 632

Western Digital Corp.
Irvine, Calif.
(714) 932-4900
CIRCLE 633

Zilog Inc.
Campbell, Calif.
(408) 370-8000
CIRCLE 634

This is meant to be used as a guide; it does not include all manufacturers.

Received,

Read,

Shared,

Analyzed,

Scrutinized,

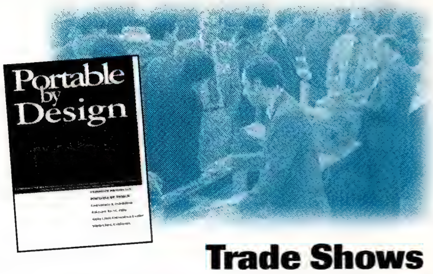
Challenged,

Archived,

and Appreciated

Over 165,000 readers can't be wrong

26 regular issues,
7 special supplements,
1 trade show,
TeleBase™ info service,
5 years on CD-ROM



Trade Shows

Portable by Design focuses on OEM designers of portable, nomadic, mobile, and transportable products.

● ● ● ● ● ● ● ●

5 Years on CD-ROM

A complete library on CD. All the articles, photos, drawings, schematics, editorials, and letters - all on one easy-to-use disk.

● ● ● ● ● ● ● ●

TeleBase™ info service

A great new way to source products. The TeleBase Directory has hundreds of categories and is updated monthly.

● ● ● ● ● ● ● ●

Special Supplements

Seven supplements released yearly focus extensively on specific topics. Supplements make great reference sources for electronic design professionals.

ELECTRONIC DESIGN

A PENTON PUBLICATION

To subscribe or to receive additional information call: 201-393-6060

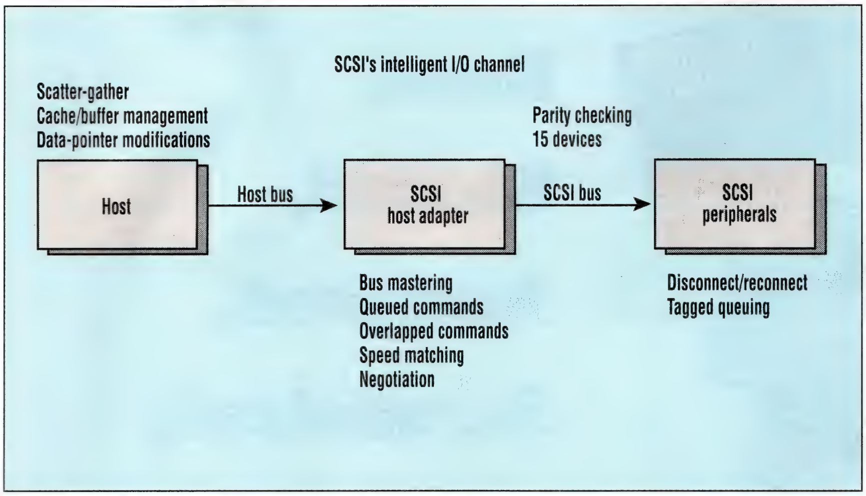
evolution in the parallel SCSI interface—the 16-bit Fast20 (40-Mbyte/s) and 16-bit Fast40 (80-Mbyte/s) options. These interfaces will deliver data at rates fast enough to support most desktop applications for the next few years.

The forthcoming SCSI-3 standard will solidify and resolve some of the problems encountered by users of the Fast SCSI-2 interface. Instead of one physical interface, SCSI-3 specifies two parallel interface options (single-ended and differential) and four serial options. Of the four serial choices, three are geared to specific physical transport standards: the serial bus protocol (SBP) for the IEEE P1394 high-speed serial bus; the serial storage protocol (SSP) for the IBM serial storage architecture (SSA) interface, and the Fibre Channel protocol (FCP) for the Fibre Channel interface. The fourth is a more generic-type interface.

Although much attention focused on maximizing the data rate at the drive connector, improvements on the interface reach a point of minimal return if data can't be transferred faster onto or off the disk itself. Current-generation drives have read channels in the 6-to-8-Mbyte/s range; however, read-channel circuits now are appearing that let will designers create drives in 1995 capable of data-transfer speeds of 80 to 100 Mbits/s (10 to 12 Mbytes/s). Drive designers are also looking at the challenges to achieving 120-Mbit/s (15-Mbyte/s) read channels for the 1996 generation of storage disk drives.

Once the drive can sustain such high internal data rates, the buffer that services the host interface—typically between 32 and 128 kbytes—can be kept full or at least refilled faster. That would minimize any data latencies, a critical issue for applications such as video servers or other time-dependent data displays. Intelligent caching algorithms, either implemented in the drive or in the host subsystem, also could look ahead by transferring the next one or two sectors into a disk cache, eliminating many of the electromechanical overheads.

However, as Mike Miller, a design manager at Seagate Technology, Minneapolis, Minn., points out, the actual host interface, although rated for, say, 10 Mbytes/s in the case of Fast SCSI, rarely achieves that data rate for any sustained period. That, he says, is due to the command overheads, the bus loading, and other factors which affect the overall data-transfer speeds.



4. DISTRIBUTED INTELLIGENCE is a key aspect of the SCSI I/O channel, as this breakdown from Adaptec illustrates. Various intelligent operations are assigned to either the host, the host adapter, or the target peripheral, permitting SCSI-based systems to perform many operations in parallel. Consequently, it operates more efficiently.

If the system is part of a client-server environment, several other elements will come into play. For one, an almost unbelievable number of software and hardware layers that access requests must navigate through just to retrieve or store data *(Fig. 3)*. And, at each step of the way, some short amount of time is required, either to execute a driver routine, to navigate through the network, or to perform the actual storage operation.

Commands that request transfers of large blocks (hundreds of kbytes) of data are actually fairly infrequent, says Quantum's Jim McGrath. He explains that long transfers are usually broken down into transfers of about 8 to 10 kbytes each, and then a sequence of smaller transfers is done.

Such a restructuring, explains McGrath, is more efficient for several reasons. First, the data might be stored across multiple disk drives, and thus multiple accesses can be executed in parallel to more quickly retrieve the information. Second, even if the data is on one drive, it may not be stored sequentially. By reducing the transfer request into smaller blocks, the drive controller may reorder the sequence of accesses to more efficiently reach the proper sectors. Firmware embedded in the drive's controller would perform the access reordering and the proper assembly of the recovered data.

However, with each access request there's an accompanying command overhead. Depending on the type of command interpreter used in the drive, the response time can range anywhere from 500 µs or longer to well under 50 µs. Going through some simple computations with the data-transfer rates and command overheads will provide some enlightening perspective.

First, if we assume a burst data-transfer speed of 10 Mbytes/s (8-bit Fast SCSI), a 10-kbyte burst would require 1 ms. If the command overhead is added to that burst time (1 ms + 0.5 ms for the older drives, or 1 ms + 0.05 ms for the high-performance drives), the maximum data-transfer rates drop below the ideal to just 6.67 Mbytes/s for the slow command interpreter and 9.5 Mbytes/s for the fast command processor. To top it off, these numbers don't even take into account the drive's seek time and other mechanical latencies.

One way to maximize bus utilization is to have multiple drives operating concurrently. Such as scenario is impractical with IDE drives, because

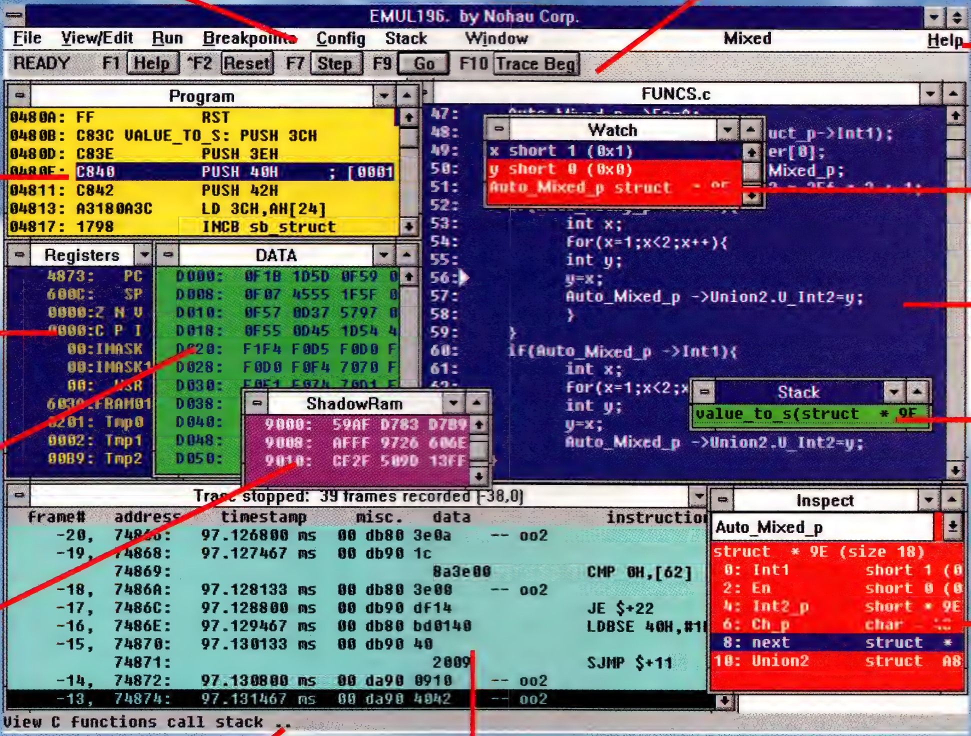
80C196

In-Circuit Emulators

Microsoft Windows 3.1 based user interface

Pull-down Menus

Speed bar (point and click)



```
0480A: FF               RST
0480B: C83C VALUE_TO_S: PUSH 3CH
0480D: C83E             PUSH 3EH
0480F: C840             PUSH 40H     ; [0001
04811: C842             PUSH 42H
04813: A3180A3C         LD 3CH,AH[24]
04817: 1798             INCB sb_struct
```

```
4873:    PC
600C:    SP
0000:Z N V
0000:C P I
  00:IMASK
  00:IMASK1
  00:   WSR
6030:FRAM01
0201: Tmp0
0002: Tmp1
00B9: Tmp2
```

```
D000:  0F18 1D5D 0F59 0
D008:  0F07 4555 1F5F 0
D010:  0F57 0D37 5797 0
D018:  0F55 0D45 1D54 4
D020:  F1F4 F0D5 F0D0 F
D028:  F0D0 F0F4 7070 F
D030:
D038:
D040:
D048:
D050:
```

```
9000:  59AF D783 D789
9008:  AFFF 9726 606E
9010:  CF2F 509D 13FF
```

```
47:
48:                                    uct_p->Int1);
49:                                    er[0];
50:                                    Mixed_p;
51:
52:
53:          int x;
54:          For(x=1;x<2;x++){
55:          int y;
56:          y=x;
57:          Auto_Mixed_p ->Union2.U_Int2=y;
58:          }
59:    }
60:    iF(Auto_Mixed_p ->Int1){
61:          int x;
             For(x=1;x<2;x
             int y;
             y=x;
             Auto_Mixed_p ->Union2.U_Int2=y;
```

```
x short 1 (0x1)
y short 0 (0x0)
Auto_Mixed_p struct  * 9F
```

```
value_to_s(struct  * 9F
```

```
Frame#  address   timestamp      misc.   data                  instruction
  -20,  748     97.126800 ms  00 db80 3e0a      -- oo2
  -19,  74868:    97.127467 ms  00 db90 1c
        74869:                          8a3e00            CMP 0H,[62]
  -18,  7486A:    97.128133 ms  00 db80 3e00      -- oo2
  -17,  7486C:    97.128800 ms  00 db90 df14              JE $+22
  -16,  7486E:    97.129467 ms  00 db80 bd0140            LDBSE 40H,#1
  -15,  74870:    97.130133 ms  00 db90 40
        74871:                          2009              SJMP $+11
  -14,  74872:    97.130800 ms  00 da90 0910      -- oo2
  -13,  74874:    97.131467 ms  00 da90 4042      -- oo2
```

```
Auto_Mixed_p
struct   * 9E (size 18)
 0: Int1           short 1 (0
 2: En             short 0 (0
 4: Int2_p         short * 9E
 6: Ch_p           char
 8: next           struct  *
10: Union2         struct  A8
```

```
View C functions call stack ..
```

On line help

Disassembler, in-line assembler Window

Watch Window for high level variables

Register Window

Source Window

Call Stack Window

Data Window

Shadow RAM shows data changes in real-time

Inspect Window

Context sensitive help line

Trace Buffer Window

MICROSOFT® WINDOWS™ COMPATIBLE

Also supported:

8051 68HC11 68HC16 683xx

FEATURES:

- Support for 80C196: KR/Q/T/C/D, JR/Q, NQ/T & more.
- Real-time emulation at maximum chip speeds.
- Use of bond-out chips for accurate emulation.
- Hosted on PC's and workstations.
- High Level support for popular C-compilers.
- Unlimited hardware breakpoints.
- Break in real-time on Internal Access, both on data value and address.
- Trace board up to 512K deep, 104 bits wide, with 40 bit timestamp. Triggering and filtering with full instruction queue decoding.
- Memory contents shown during real-time emulation (Shadow RAM).
- Code Coverage and Program Performance Analysis.
- CCB's controlled from user interface. (Wait states, timing mode, bus width and more.)

To learn more, *please call (408) 866-1820 for a FREE Demo Disk. For more information via your Fax, call our 24-hour Information Center at (408) 378-2912.*

NOHAU
CORPORATION

51 E. Campbell Avenue
Campbell, CA 95008-2053
Fax. (408) 378-7869
Tel. (408) 866-1820

Argentina 1 312-1079, Australia (02) 654 1873, Austria 0277 20-0, Benelux (01858) 16133, Brazil (011)-458-8755, Canada 1-514-689-5889, Czechoslovakia 0202-2683, Denmark 43 44 60 10, Finland 90-4526-21, France (1) 69 41 28 01, Germany 49-7043-40247, Great Britain 0962-733140, Greece 1-924 20 72, India (0212) 422164, Israel (03) 491202, Italy (011) 437 15 51, Korea (02) 784-7841, New Zealand 09-3092464, Norway 22-67 40 20, Portugal 01-80 95 18, Romania 961-30078, Singapore 749-0870, Slovenia 061-445-526, S.Africa (021) 23-4943, Spain (93) 276 22 69, Sweden 040-92 24 25, Switzerland 01-740 41 05, Taiwan 02 7640215, Thailand (02) 281-9596.

READER SERVICE 124

they're typically single-operation-at-a-time devices. But SCSI devices all handle much more complex operations and can perform command queuing and multithreading with multiple drives active simultaneously. Consequently, that combination would let the host system send out multiple requests for information or writes to the disks without waiting for a response to the initial request.

After a SCSI drive receives a command, it will often disconnect itself from the bus to start executing that command, which could take hundreds of microseconds plus whatever electromechanical latencies exist in the drive itself. Such latencies could add 5 to 15 ms more to the overall time the drive is off-line. When the drive is ready to respond, it would reattach itself to the bus and return either some type of command response or begin a data transfer.

This multitasking, queuing capability for SCSI-based storage is ideally matched to the complex operating environment of Unix and Unix-like operating systems. By sending out a series of access operations that could be queued across multiple drives, the bus can be shared and the use of its bandwidth maximized.

Unlike the IDE market in which most of the control intelligence lies within the drive, SCSI systems split the intelligence between the host and drive—or in SCSI parlance, the initiator and target, respectively *(Fig. 4)*. Thus, SCSI controller chips are optimized depending on whether they're intended to be used inside the drive, or on an adapter card or computer motherboard. Companies that make chips aimed at target applications don't necessarily make SCSI controllers for initiators, and, vice versa, companies that sell SCSI controllers optimized for initiator roles may not offer chips for targets.

Major suppliers of chips aimed at the target drives include Adaptec, Cirrus Logic, QLogic, Silicon Systems, Western Digital, and a few others. Chips optimized for target applications tend to have hardware-supported command interpretation and execution. By automating the routine tasks, minimal overheads are encountered by the host-system requests, which speeds responses.

In contrast, host-optimized chips tend to allow more processor support of their operations. Part of the reason is that the host system (a workstation or high-end PC, for example) can provide more compute power to execute the commands than the 8- or 16-bit microcontroller typically embedded in the disk drive. Furthermore, as the CPU performance is upgraded, the performance of the host SCSI controller also improves, better matching the overall system performance.

One of the newest target-optimized SCSI controllers, the Adaptec AIC-8320, can handle read-channel data rates of up to 100 Mbits/s and deliver peak data-bus transfer rates of 20 Mbytes/s over Fast/Wide SCSI ports, or 10 Mbytes/s over an 8-bit interface. In addition, the controller supports a local buffer RAM that offers a data-transfer bandwidth of up to 48 Mbytes/s, maximizing overall drive data throughput. This chip supplies a superset of features and higher data bandwidths than the company's previous target chip, the model AIC-8210.

At its heart, the AIC-8320 packs a programmable sequencer used by Adaptec in many of its products. The sequencer represented by the Core Controller Technology performs the command parsing, manages the buffer, and controls the disk operations. The buffer can be implemented with 32 kbytes of SRAM or up to 4 Mbytes of DRAM. Many of the SCSI sequences are automated, including operations like target transfer disable and continued I/O processes, functions ideal for implementing software disk arrays and in handling multimedia data files. The automation also keeps command overheads low—Bus Free and Read Command to Disconnect require less than 15 µs. In addition, dual 16-byte SCSI command FIFOs buffer incoming commands, while a 32-byte SCSI data FIFO buffers DMA transfers between the SCSI port and the local buffer memory.

To ensure high data integrity, Adaptec's designers added a high-throughput programmable block that performs 297-bit, 3-way, interleaved, R-S error checking and correction that can fix errors on-the-fly. The ECC block can perform single-burst on-the-fly corrections of up to 41 bits in hardware and 113 bits in software. Double-burst on-the-fly corrections of 17-bit errors can be done in hardware, or five bursts can be handled in software. That yields minimal data-recording or recovery problems and has no negative effect on data-transfer speeds. On top of that, the data-field identifiers (the fields used to locate the data) are protected with their own 3-way, interleaved ECC.

Cirrus Logic's CL-SH5500 and SH5700 controllers deliver the 20-Mbyte/s Fast/Wide data rates. They use a 16-bit-wide interface to the local buffer memory and can perform full data streaming and automatic SCSI command processing. The read-channel interface employs a 2-bit non-return-to-zero (NRZ) coding scheme that allows data rates of up to 72 Mbits/s to occur on the serial read channel.

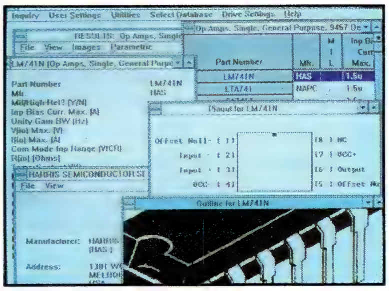
The SH5500 utilizes off-chip logic to add ECC, while the SH5700 has built-in ECC logic. The built-in logic consists of Cirrus' proprietary 88-bit on-the-fly R-S algorithm, which can keep pace with the 72-Mbit/s read-channel data stream. On-chip 48-mA drivers and active pull-ups let the chip connect directly to the SCSI connector, eliminating the need for bus buffers and reducing the number of components in the drive. A forthcoming enhanced version will add support for the automatic drive-ID configuration. Dubbed SCSI configured automagically (SCAM 2), it will allow the drive to set its own SCSI ID number when the system is turned on, dramatically simplifying the process of system configuration and maintenance *(Fig. 5)*.

At Silicon Systems, the focus on SCSI target logic lets designers at the company optimize their support and include target intiator modes for reconnect, or file copy. Silicon Systems hopes to differentiate its offering by delivering an architecture that's compatible across both AT and SCSI controllers. That would enable drive manufacturers to retain most of their firmware and ease the development of companion products.

Existing Silicon Systems controllers, the 9023 and 9024, support 80-

Introducing CAPSXpert.® The best of two component databases combined into one Windows™ tool.

Some of the finest things in life result from ideal combinations. When IHS® wanted to create the world's most powerful component selection tool, we combined the strengths of CAPS and IC/Discrete with the functionality of Windows to bring you the ultimate — CAPS*Xpert*.



Part Number	Mfr.	Inp Bi Curr Max.
LM741N	HAS	1.5u
LTA741	NAPC	1.5u

Part Number LM741N
Mfr. HAS
Mil/High-Rel? [Y/N]
Inp Bias Curr. Max. [A]
Unity Gain BW [Hz]
V[io] Max. [V]
I[io] Max. [A]
Com Mode Inp Range [VICR]
R[in] [Ohms]

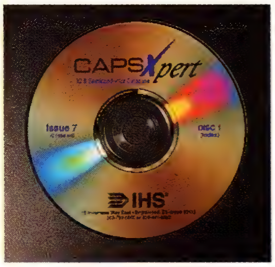
Offset Null- [1] [8] NC
Input - [2] [7] VCC+
Input + [3] [6] Output
VCC- [4] [5] Offset Nu

Manufacturer: HARRIS (HAS)
Address: 1301 WO MELBOU

CAPS*Xpert* will revolutionize the way you search and compare components. CAPS*Xpert* gives you:

• More data • Unbeatable currency • User-defined upgrade and downgrade criteria • Graphical pinout and package displays • Distributor and sales office listings. Innovative search commands and multiple window capabilities make finding the current information your engineering team needs faster and easier than ever before. CAPS*Xpert* is the tool you need to reduce redesign costs, avoid expensive product delays, and meet critical design cycles.

For the ultimate solution to faster, easier component selection, upgrade to CAPS*Xpert* today! Call 1-800-241-7824 or 303-790-0600, ext. 59.



IHS®

CAPSXpert. Nobody Puts It Together Like IHS.®

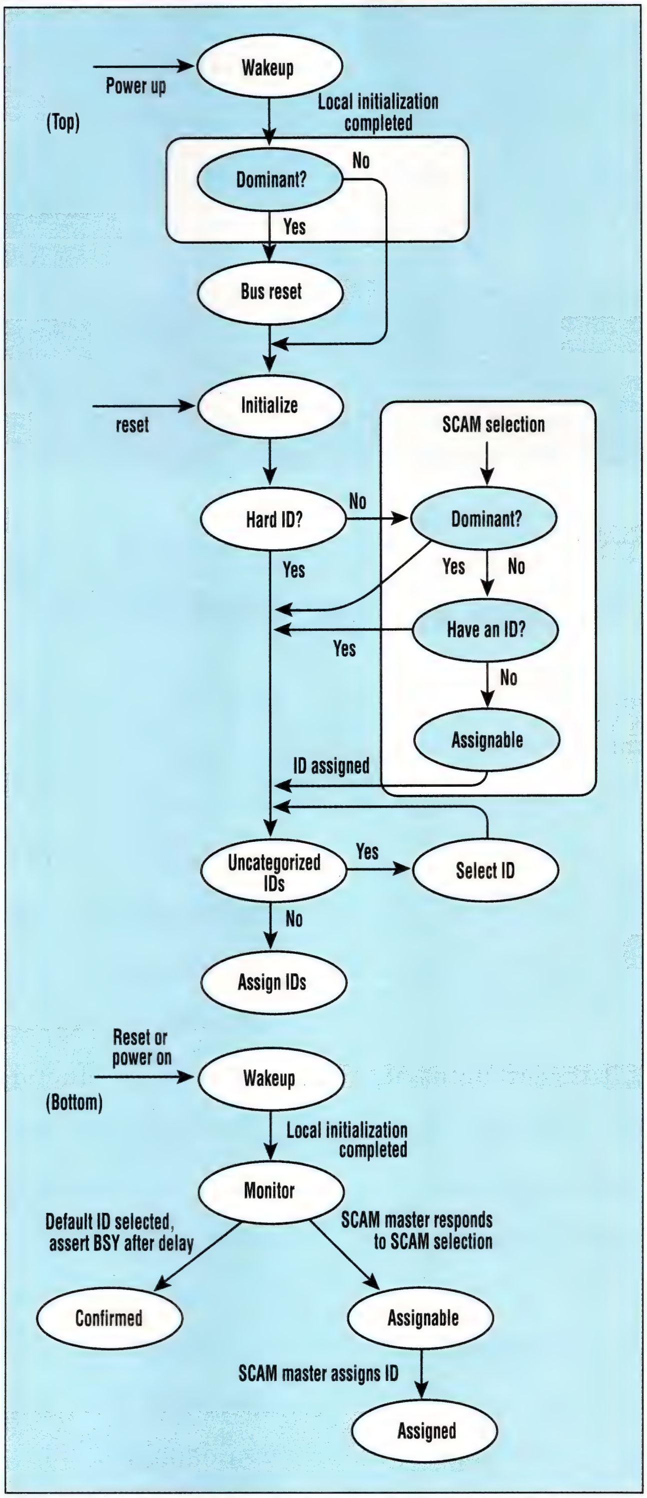
Available in Windows for PCs and network configurations. Call for UNIX update.

READER SERVICE 191

Mbit/s disk transfer rates over the read channel and Fast SCSI data rates (20 Mbytes/s) over a 16-bit host interface. Forthcoming controllers in the 9800 series are being developed as the new Fast/20 and Fast/40 standards evolve. The company hopes to start sampling the Fast/20 target controller some time next quarter. The controller will support SCAM 2, the latest revision of the autoconfiguration portion of the forthcoming SCSI-3 standard.

Fast SCSI support also is included as part of the WD61C96A from Western Digital. The circuit combines all of the functions of the previously available WD61C40 disk controller and the WD33C96 SCSI controller, and includes task files of the microprocessor-accessible registers, a 16-bit memory buffer interface and controller for up to 8 Mbytes of buffer memory, a 16-bit DMA interface (which can be pipelined to 24 bits), and a 16-bit Fast/Wide SCSI port. Single-ended bus drivers that meet the 48/60-mA drive requirements proposed by the SCSI-3 interface help reduce the drive component count even further and make it possible to connect directly to the SCSI cable.

The embedded state machine that controls the SCSI operations keeps overheads to a minimum: The total time required to perform arbitration, selection, command transfer, and message transfer is less than 20 μs. Both the SCSI and DMA interfaces can be programmed independently for 8- or 16-bit data transfers. The programmable state machine that controls the SCSI protocol handling has a 128-word writable control store, which allows users to create custom control sequences to optimize the protocol handling to their application. A second writable control store in the disk-controller portion allows the system drive designer to define the disk format if a fixed sector and track format doesn't suit the particular application.



5. THE UPCOMING STANDARD FOR THE automatic configuration of SCSI device IDs, known as SCAM, is a concept disk-drive manufacturers like Quantum and all users can appreciate. By following a standard sequence as a SCAM master or slave, the SCSI master can automatically determine the active devices and then assign an ID number to each target. This mapping is done during each startup sequence. It thus permits the system configuration to change as often as desired. If SCAM isn't invoked, the peripheral refers back to a default ID preset by the disk-drive manufacturer.

Efforts are underway at Western Digital to create Fast/20 and Fast/40 target controllers as well. Initially, the company will have a two-chip solution—the WD34C96A controller and WD62C40 buffer manager. By late 1995, a fully-integrated version, the WD62C296, will be released.

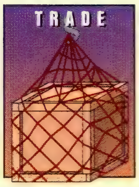
Host-side SCSI controllers also are becoming more highly integrated, with most of the latest offerings embedding a high-speed local-bus interface (PCI or VL-Bus) to maximize data throughput. In addition, several more highly integrated chips have added a network interface controller as well—both NCR and Advanced Micro Devices now offer combo chips that include SCSI and Ethernet controllers on one piece of silicon. NCR's version was developed for the Sun workstation and employs a generic host-bus interface, while the AMD chip is optimized for the PC world and includes a PCIbus interface.

Generic SCSI controllers still are in wide use for both PC and workstation applications, as well as for other vertical applications like RAID controllers, which may have a proprietary internal backplane. Mainstays such as the NCR 53C80, 53C400A, and 53CF406A series; the QLogic (formerly known as Emulex) FAS-200 series and the TEC200 and 300 series; and the Western Digital WD33C95A and 33C96A (single-ended and differen-

COMPLIMENTARY ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:



- **Telecommunications**
- **Semiconductors**
- **Computers**
- **International trade**

☐ **YES!** Send me my **FREE** issue of ***ELECTRONICS*** and enter my 1-year subscription, 23 issues—**for 10% off the regular subscription rate!** If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates (U.S. funds drawn from a U.S. bank):

☐ U.S. ~~$98~~ $88 ☐ Canada ~~$120~~ $108 (plus GST) ☐ Other Countries ~~$190~~ $171

Please bill my credit card: ☐ Visa ☐ MasterCard ☐ AMX ☐ Discover

Card No. ______________________ Exp. Date ______________________

Signature ______________________ Date ______________________

Name ______________________ Title ______________________

Company ______________________

Mailing Address ______________________

Order by FAX: 216/696-6413 or call 216/696-7000, x 4137

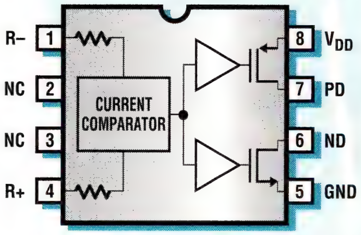
1EDh4c

Power Control Made Easy!

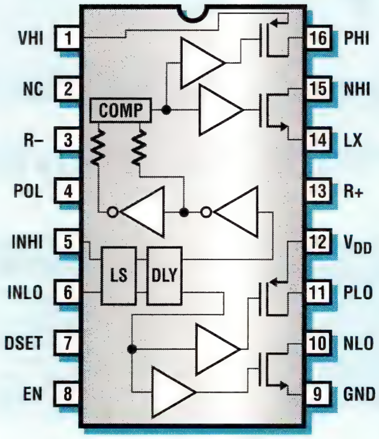
DESIGN ADVANTAGE: • Solves Below Ground Ringing • No Start-Up Uncertainty • No False Triggering

The Family of 1 MHz MOSFET and IGBT Drivers

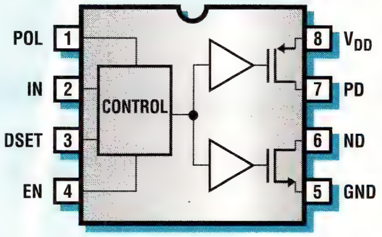
EL7501C
High Side Driver



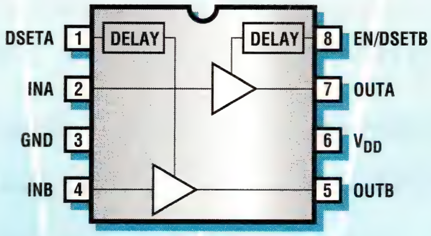
EL7761C
Half Bridge Driver



EL7861C
Single Delay Driver



EL7961C/7971C/7981C
EL7962C/7972C/7982C
Dual Delay Drivers



FEATURES

- Dielectrically Isolated 100V High Side
- Programmable Time Delay
- Direct Coupled to High and Low Side
- Noise Blanking Circuitry
- Isolated Drains for Versatile Output Connection
- Break-Before-Make Switching
- Call Us for Many More Features

APPLICATIONS

- Uninterruptible Power Supplies
- DC/DC Converters
- Switch Mode Power Supplies
- Resonant Switching Supplies

- Pricing Begins at $2.38, P-DIP, 1,000-unit volumes (Also Available in SO)

CALL FOR OUR FULL-LINE
CMOS POWER PRODUCT
DATABOOK, NOW AVAILABLE

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

FOR SAMPLES CALL
(800) 333-6314 ext 311
For Literature Only– ext 234

ELANTEC, INC. ▪ 1996 Tarob Court ▪ Milpitas, CA 95035 ▪ (408) 945-1323 ▪ (800) 333-6314 ▪ FAX (408) 945-9305

Authorized Distributors: Marshall Industries ▪ Nu Horizons ▪ Insight Electronics

READER SERVICE 264

tial, respectively) continue to be incorporated into many moderate-performance designs.

Designed to meet the SCSI-2 requirements along with SCAM-2 support for autoconfiguration, the NCR 53CF92 satisfies the 8-bit Fast SCSI specifications. It delivers 5 and 10 Mbytes/s in the asynchronous and synchronous modes, respectively. Included on the chip are a 24-bit transfer counter for DMA data transfers of up to 16 Mbytes with no intersector transfer delays, and a part-unique ID code that serves as a default if the SCAM setup isn't used. The chip is targeted for low-cost applications, such as in low-end CD-ROM adapters. And, as with all NCR SCSI controllers, the circuit includes the company's TolerANT active negation interface logic. TolerANT receiver technology improves data integrity in potentially unreliable cabled environments by filtering the SCSI bus signals to eliminate unwanted transitions without the long signal delays common among RC-type filters.

PCI to SCSI controllers are cresting in popularity these days, with Adaptec, Advansys, AMD, BusLogic, Future Domain, NCR, QLogic, Western Digital, and other companies coming out with high-performance SCSI controllers. However, these companies have gone several different architectural routes. One of these embeds a high-performance RISC processor on the chip to quickly execute the commands, manage the task queues, connect/disconnect, command reordering, etc.

Another approach puts many of the simpler SCSI command sequences into hardwired operations and uses the host system's 32-bit CPU to perform the more complex commands. Such a scheme simplifies the silicon and reduces chip cost, but it will place somewhat of a burden on the host-system CPU. In addition to slicing silicon cost, performance improves as the host CPU's performance improves. However, if the host CPU is bogged down with an uninterruptible task, disk-drive performance also can suffer.

By using a hardware command interpreter, a pair of SCSI processors developed by Future Domain—the 18PNP300 and 36C70—provide plug-and-play compatibility on the ISA and PCI buses, respectively. The 18PNP300 eliminates the need for jumper settings on boards and supports data-transfer rates of 10 Mbytes/s on a SCSI-2 port. Designed with software developers in mind, it lets them use 32-bit (double-word) instructions, improving transfer rates by about 15% compared with controllers that employ 16-bit instruction transfers. A 512-byte FIFO helps alleviate data-transfer bottlenecks by holding many times the data that other controllers keep in on-chip FIFO buffers.

Addressing the PnP PCI interface, the 36C70 increases the FIFO buffer to four times that of the ISA chip. The chip's 2-kbyte FIFO allows the controller to sustain 10-Mbyte/s synchronous data transfers, even without the on-chip intelligence of a RISC-based controller like the NCR 53C810. Designed to be pin-compatible with the NCR chip, the 36C70 claims a higher throughput than the NCR controller but includes an interface to a serial ROM for local BIOS storage. The 53C810 can't address a local BIOS; however, two other NCR controllers in the 53C800 series have that capability.

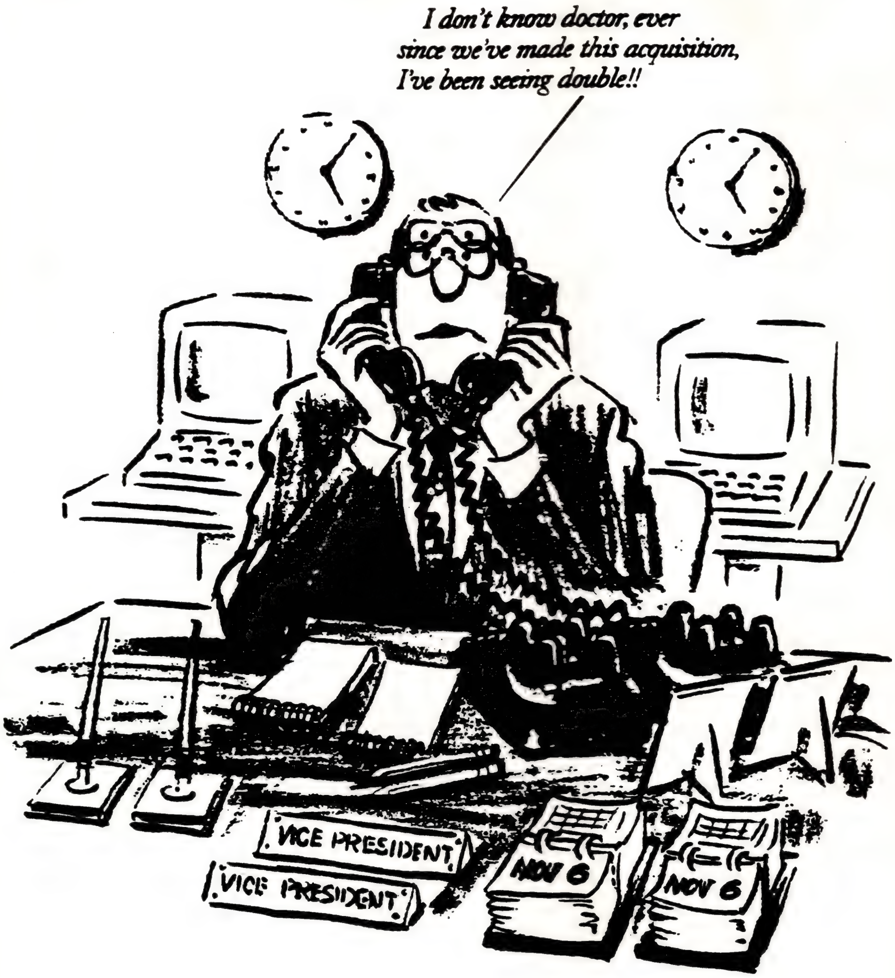
NCR and Adaptec were the first companies to embed a high-performance RISC engine on their controllers. The 53C700 (generic-bus interface) along with the recently upgraded 53C800 PCI-compatible series SCSI controllers from NCR thus could reduce command overheads to less than 50 µs. The RISC engine executes code sequences NCR calls SCRIPTS, which permit users to easily upgrade the system with firmware as improved command sequences are developed.

Several other companies also adopted similar approaches with internal RISC engines. These include Adaptec with its proprietary Phase-Engine RISC core on its AIC-7850/7870 Fast and Fast/wide SCSI controller chips. Advansys has its ASC1200, a PCI-to-Fast-SCSI controller (Advansys also has the ASC1000, a VLbus-to-Fast-SCSI controller); QLogic offers the ISP1020 PCI-to-Fast-SCSI controller. A second QLogic version, the ISP1000, provides a direct interface to the SparcStation SBus; and Western Digital now is sampling the model 33C196A, a single chip PCI-to-SCSI adapter.

The QLogic controllers actually go one-step further by employing two programmable processors on the chip, one to handle thread management and the other for SCSI command operations. As a result, no host intervention is needed for the chip to execute SCSI operations from start to finish, including the execution of simultaneous, multiple threads. The internal SCSI processor can perform synchronous transfers at 20 Mbytes/s and asynchronous transfers of up to 12 Mbytes/s. A dual-channel DMA controller on the PCI-bus portion, with one channel dedicated for command operations and the other dedicated for data transfers, also sports a 64-byte FIFO on each channel to minimize latencies. The Advansys chips, the latest entries into the market, claim some of the shortest command overheads—just 12 µs each for the simpler commands. New operations can be started within just 10 µs after the current command finishes. Furthermore, from the idle state, the model ASC-1000/1200 can start a command in just 5 µs (ELECTRONIC DESIGN, *June 13, p. 150)*.

Data transfers over the PCI interface with these chips can take place at the bus clock (33 MHz). Consequently, buffer-to-host bursts can occur at 110 Mbytes/s with NCR's 53C810, while Adaptec and Advansys claim 132 Mbytes/s for their chips. Multitasking and multithreading, two key features of SCSI-2, are exploited by these RISC-based chips. The controllers can support up to 255 active SCSI I/O tasks as well as perform scatter-gather operations with on-chip hardware support. To help accelerate the data, Adaptec's designers included a 128-byte data FIFO buffer to reduce any system latencies.

The NCR 53C800 series chips, the industry's first PCI-compatible SCSI controllers, still are somewhat unique because they're supported with a universal SDMS (SCSI device management system) BIOS. The single BIOS makes it easy for designers


I don't know doctor, ever since we've made this acquisition, I've been seeing double!!
VICE PRESIDENT
VICE PRESIDENT
NOV 6
NOV 6

Turn your **excess inventory** into a substantial tax break and help send needy **kids to college** as well.

Call for your **free guide** to learn how donating your slow moving inventory can mean a generous **tax write off** for your company.

Call (708) 690-0010
Peter Roskam
Executive Director

EAL

P.O. Box 3021, Glen Ellyn, IL 60138
FAX (708) 690-0565

Excess inventory today...student opportunity tomorrow

to create optimized solutions since all of the chips are software-compatible. Furthermore, system designers needn't stack multiple BIOS sequences in the RAM, which saves valuable active memory space. The chips are compatible with the PCI plug-and-play (PnP) and SCSI configured automagically (version 1) initiative (SCAM is the SCSI side of PnP). An additional upgrade that extends compatibility to SCAM-2 is now being developed.

Several versions of the 53C800 controller exist, all of which function as a 32-bit PCI DMA bus master. However, the 53C810 doesn't support a local ROM interface, unlike the 53C815 and 825. The local ROM interface allows the 8-bit single-ended 53C815 or the 8/16-bit (single-ended or differential) 53C825 to address up to 1 Mbyte of local memory (flash or EPROM), offloading the host bus for BIOS transfers. The chips can perform burst transfers of 2, 4, 8, or 16 long words across the PCI bus using a 64-byte FIFO.

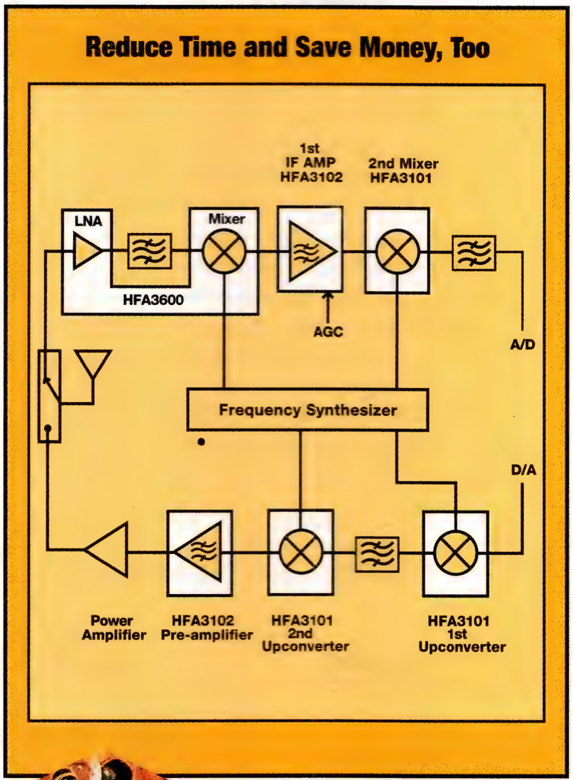
Based on the core used in its WD33C96A controller, the 33C196A provides 8- or 16-bit Fast SCSI support and keeps the command overheads to less than 20 µs. The chip also provides low-level bus control and includes slew-rate-controlled, 60-mA, active-negation SCSI-bus drivers. On the host side, the chip serves as a PCI bus-master DMA controller, transferring data at 132 Mbytes/s and performing seamless, variable-length scatter-gather transfers.

At the heart of the chip lies a 16-MIPS RISC engine that ties into a 2-kword instruction buffer RAM and a 256-byte, SCSI-control block memory. On the PCI-bus interface, a three-channel DMA controller and a 24-bit pipelined transfer counter support the high-speed data transfers. On the SCSI bus side, a 32-byte FIFO buffer and a pipelined 24-bit transfer counter support a microcoded state machine that performs the bus-control function.☐

HOW VALUABLE?	**CIRCLE**
HIGHLY	537
MODERATELY	538
SLIGHTLY	539

SHRINK YOUR WIRELESS DESIGN AND YOUR COSTS WITH HARRIS SILICON RF ICs.

Squeeze ounces and inches out of your next wireless project – and dollars out of your cost budget – with new RF front end ICs from Harris. Our HFA3600 LNA/Mixer gives you low-power, low-noise 900 MHz performance in 40% less space than discretes. Yet they cost just $1.82 each in 5000 piece quantities. And it's part of a whole family of high-performance, low-cost Harris silicon RF ICs, including our HFA3102 Dual Long-Tailed Pair Transistor Array and HFA3101 Gilbert Cell. They all pack a lot of product into a package that's compact – with a price to match.



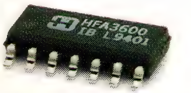
Features

HFA3600 LNA/Mixer

- Power consumption: 11mA @ 5V, 1.2 mW (sleep mode)
- LNA noise figure: 2.3dB
- Mixer OIP: +3.2dBm
- Integrated 50Ω matching
- Integrated power down function
- Just $1.82 (5000s)

HFA3102 Dual Long-Tailed Pair Transistor Array and HFA3101 Gilbert Cell

- Power Gain Bandwidth: 5 GHz
- Current gain: 70
- Excellent hfe and Vbe matching
- Just $1.80 (5000s)



As with the HFA3600, the honeybee packs a lot of potential in a small package and the rewards are inexpensively sweet.

HARRIS SEMICONDUCTOR
ANSWER FAX

Call 407-724-3818 and request documents:
3655(HFA3600), 3635(HFA3101), 3663(HFA3102).
Or call 1-800-4-HARRIS and ask for extension 7266.

HARRIS
SEMICONDUCTOR

READER SERVICE 206

HARNESS THE POWER OF VHDL FOR PLD DESIGN

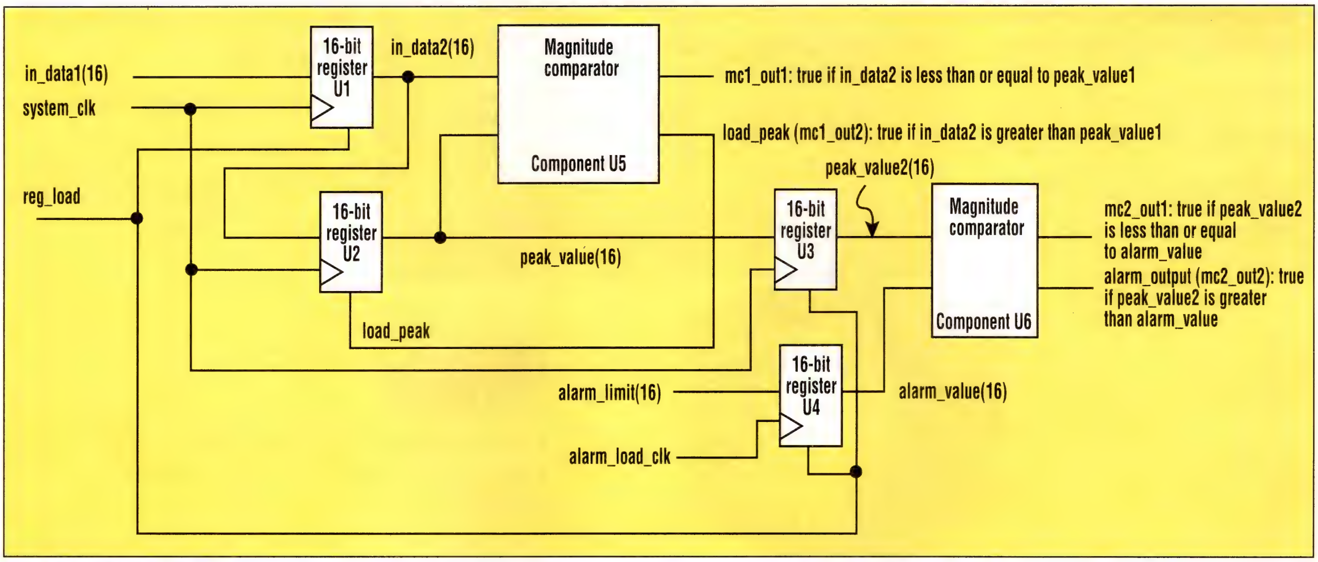
Tips And Techniques Help VHDL Newcomers Avoid Common Pitfalls And Make Intelligent Use Of The Language.

Historically, engineers have used hardware-description languages (HDLs) to capture logic for implementation in programmable-logic devices (PLDs). Most often, these languages were proprietary to the specific tool that was used, and they didn't easily accommodate large or complex designs. However, because the target PLDs were relatively small and had a straightforward sum-of-products architecture, these rudimentary tools usually were adequate.

In recent years, however, PLDs have increased dramatically in capacity and complexity. Also, higher levels of abstraction and hierarchy in design description have become desirable to help engineers conceptualize and manage complex designs.

Today, system-level logic design is frequently a team enterprise, forcing modular decomposition and implementation. This, in turn, demands a modular, hierarchical design approach. And to allow system integration and verification, design transfer from one environment to another must be kept simple. Furthermore, evaluating many device implementation options without translation (or worse, reentry) of the source design description is an increasingly important requirement.

The IEEE-standard VHDL language addresses these needs. This powerful HDL is widely endorsed as the standard for all phases of electronic system and component design. It's required by the U.S. Department of Defense and the General Services


in_data1(16)
system_clk
reg_load
16-bit register U1
in_data2(16)
Magnitude comparator
Component U5
mc1_out1: true if in_data2 is less than or equal to peak_value1
load_peak (mc1_out2): true if in_data2 is greater than peak_value1
peak_value2(16)
16-bit register U2
peak_value(16)
load_peak
16-bit register U3
Magnitude comparator
Component U6
mc2_out1: true if peak_value2 is less than or equal to alarm_value
alarm_output (mc2_out2): true if peak_value2 is greater than alarm_value
alarm_limit(16)
16-bit register U4
alarm_value(16)
alarm_load_clk

1. THIS 16-BIT peak-value detector is built with two magnitude comparators and four registers. The performance of the magnitude comparator U5 determines the rate at which incoming data words can be processed.

AL GRAF
Cypress Semiconductor, 3901 N. 1st St.,
San Jose, CA 95134; (408) 943-2133.

You're just what I've been looking for.

You're so svelte... and so cool.

So powerful – I've never felt so safe...

...and you look great in black!

What did you say your name is...?

Administration for documenting contracted systems and component design work. Now, design and synthesis tools like Cypress' Warp native VHDL PLD compiler are available to bring this language to PLD users at reasonable prices.

This article explores the application of VHDL to PLD design. It aims to help VHDL newcomers become effective quickly and avoid common pitfalls. We begin with hierarchical design, and show how to determine when to use behavioral and structural design styles. Then, we elaborate on specific tips and techniques that help in getting the most from the two styles. Where appropriate, VHDL-compiler options that make the best use of PLD architecture features are discussed.

VHDL brings the power of hierarchy to the PLD design process, and permits concurrent development of separate parts of a large, complex system. Also, to speed the design process and increase first-pass success, you can develop proven design entities, store them as components in libraries, and call them up repeatedly for reuse. Effective use of hierarchy and user-defined component libraries can boost productivity dramatically.

Consider, for example, predefined library components, local signal (data pathway) declarations, and port map statements that implement a VHDL structural design file *(Listing 1)* that describes the physical logic *(Fig. 1)*. The file creates a 16-bit peak-value detector/monitor circuit that continuously monitors an input stream of 16-bit binary values and saves the largest one. It then compares the peak value with a predetermined alarm limit.

Note that the design file uses three previously defined components: two 16-bit magnitude comparators (mag16_comp1, mag16_comp2), and a 16-bit D-type register with load enable (reg16_v1). It calls the components from the appropriate library directory with statements at the top of the file, and by the component declarations in the architecture body. The latter declare the port names, which are defined in the library files for the component entities to be used. More specifically, the port names for component mag16_comp2 (U6) are identical to those in the behavioral design for the same component *(Listing 2)*.

However, the design descriptions of the components needn't appear in a high-level structural design file. This frees you to design the components at a later time, or to design them in parallel—without modifying the high-level file that calls them.

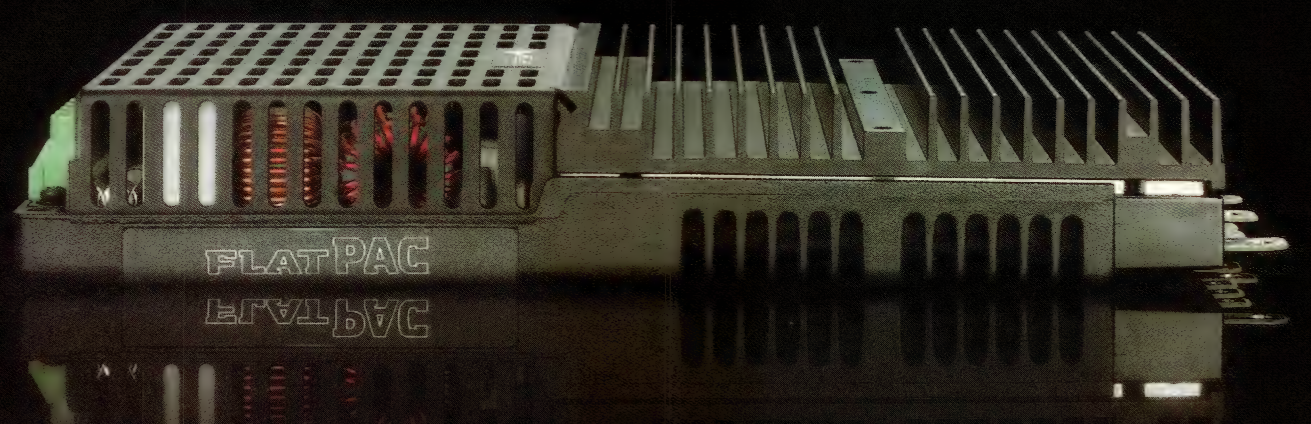
An entity declaration defines the interface of the design element to the external system, while the architec-

LISTING 1: VHDL STRUCTURAL DESIGN FILE

```
--Cypress WARP Native VHDL PLD Compiler
--File Name : pk_mon01.vhd
--16 Bit Peak Value Detector/Monitor
--Author: Al Graf

use work.cypress.all;
use work.rtlpkg.all;
use work.bv_math.all;
use work.mag16_comp1;                                                              --previously compiled entities
use work.mag16_comp2;                                                              --to be used as components
use work.reg16_v1;

entity peak_monitor1 is                                                            --entity declaration
       port(system_clk, alarm_load_clk, reg_load : in bit;
               mc1_out1, mc2_out1, alarm_output : out bit;                         --entity port names
               in_data1, alarm_limit: in bit_vector(0 to 15);
end peak_monitor1;

architecture one of peak_monitor1 is                                               --architecture declaration
      signal load_peak: bit;
      signal in_data2: bit_vector(0 to 15);                                        --local signal
      signal peak_value1: bit_vector(0 to 15);                                     --declarations, used
      signal peak_value2: bit_vector(0 to 15);                                     --to connect
      signal alarm_value: bit_vector(0 to 15);                                     --components

      component mag16_comp1(a, b: in bit_vector(0 to 15);                          --component declarations
                                 lesser, greater: out bit);

      end component;
      component mag16_comp2(a, b: in bit_vector(0 to 15);
                                 lesser, greater: out bit);

      end component;
      component reg16_v1(d: in bit_vector(0 to 15);
                         q: out bit_vector(0 to 15);
                               load, clock : in_bit);

      end component;

      begin
           U1: reg16_v1 port map(in_data1, in_data2, reg_load, system_clk);        --architecture body
           U2: reg16_v1 port map(in_data2, peak_value1, load_peak, system_clk);    --port-map statements
           U3: reg16_v1 port map(peak_value1, peak_value2, reg_load, system_clk);  --create netlist of
           U4: reg16_v1 port map(alarm_limit, alarm_value, reg_load, system_clk);  --component instantiations
           U5: mag16_comp1 port map(in_data2, peak_value1, mc1_out1, load_peak)
           U6: mag16_comp2 port map(peak_value2, alarm_value, mc2_out1, alarm_output);
end;
```

"I'm FlatPAC...

...I'll respond to any line you feed me!"



Vicor's Autoranging FlatPAC, AC-DC Switcher

Low Profile, 1.37"H • Configurable • Agency Approved

- **Inputs: 115/230 VAC Autoranging**
- **Up to 3 Outputs: 1 to 95 VDC**
- **VDE/FCC Class "A" and/or "B"**
- **30 mS Holdup**
- **UL, CSA, TÜV, VDE 0805, EN 60950, IEC 950**
- **Meets IEC 801-5, Level 3**
- **80-90% Efficiency**
- **BUS OK and AC OK**
- **Output Disable**
- **ZCS Power Architecture**
- **Low Noise FM Control**

Component Solutions For Your Power System

Vicor Corporation 23 Frontage Road • Andover, MA. 01810 USA • Tel: (508) 470-2900 • Fax: (508) 475-6715
Vicor GmbH Carl-von-Linde Strasse 15 D-85748 Garching-Hochbruck, Germany • Tel: +49-89-329-2763 • Fax: +49-89-329-2767
Vicor Asia-Pacific 10F, No. 7, Ho Ping E. Road, Sec. 3, Taipei, Taiwan • Tel: +886-2-708-8020 • Fax: +886-2-755-5578

VICOR

READER SERVICE 144

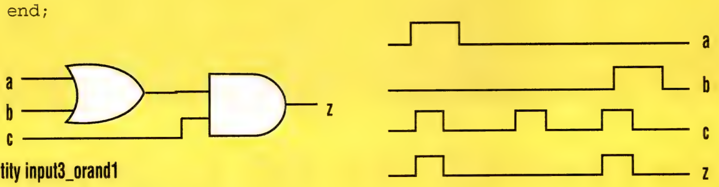
ture body defines the internal structure of the entity. The three previously defined components (the two comparators and the register) are called by component declarations and instantiated several times in the architecture body of Listing 1 by using port map statements. This is what creates the net list for the design.

The port map statements assign the local signals (defined in the header of the architecture) to the ports of the components by positional reference. Understand that the components you use may themselves be designs that incorporate other library components, and that they can be implemented at any level of hierarchy by nesting components in design entities.

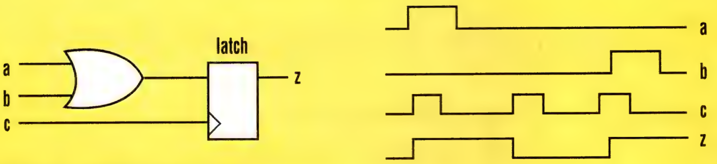
The process, which describes the function of an entity, is the defining element of a behavioral description. Listing 2 describes component mag16_comp2 (U6) behaviorally in the mag_comp:process statement within the architecture body at the end of the file. One great benefit derived from a behavioral design is the compact and efficient description it allows, from which the function of the entity is clear.

However, the ease of creating a component's behavioral description comes at a sacrifice: control. You become dependent on the synthesis policy of the VHDL compiler for the structural representation that's ultimately implemented in the PLD. Also, the compiler's implementation frequently won't be as speed-efficient as a handcrafted structural implementation, which a skilled designer can implement to take full advantage of the target PLD's resources.

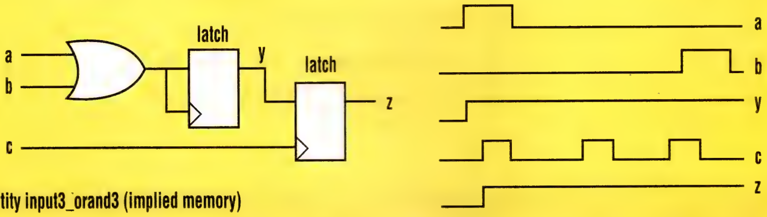
```
use work.cypress.all;                   --library declarations
use work.rtlpkg.all;

entity input3_orand1 is                 --entity declaration
   port(a,b,c:in bit;                   --port statement
            z:out bit);
end input3_orand1;

architecture one of input3_orand1 is    --architecture "one" of
                                        --entity input3_orand1
begin

   orand3:process
   begin
   IF (c = `1') THEN

         IF (a = `1' or b = `1') THEN z <= `1';
         ELSE z <= `0';
         END IF;

   ELSE z <= `0';
   END IF;
   end process;

end;
```



(a) entity input3_orand1



(b) entity input3_orand2 (implied memory)



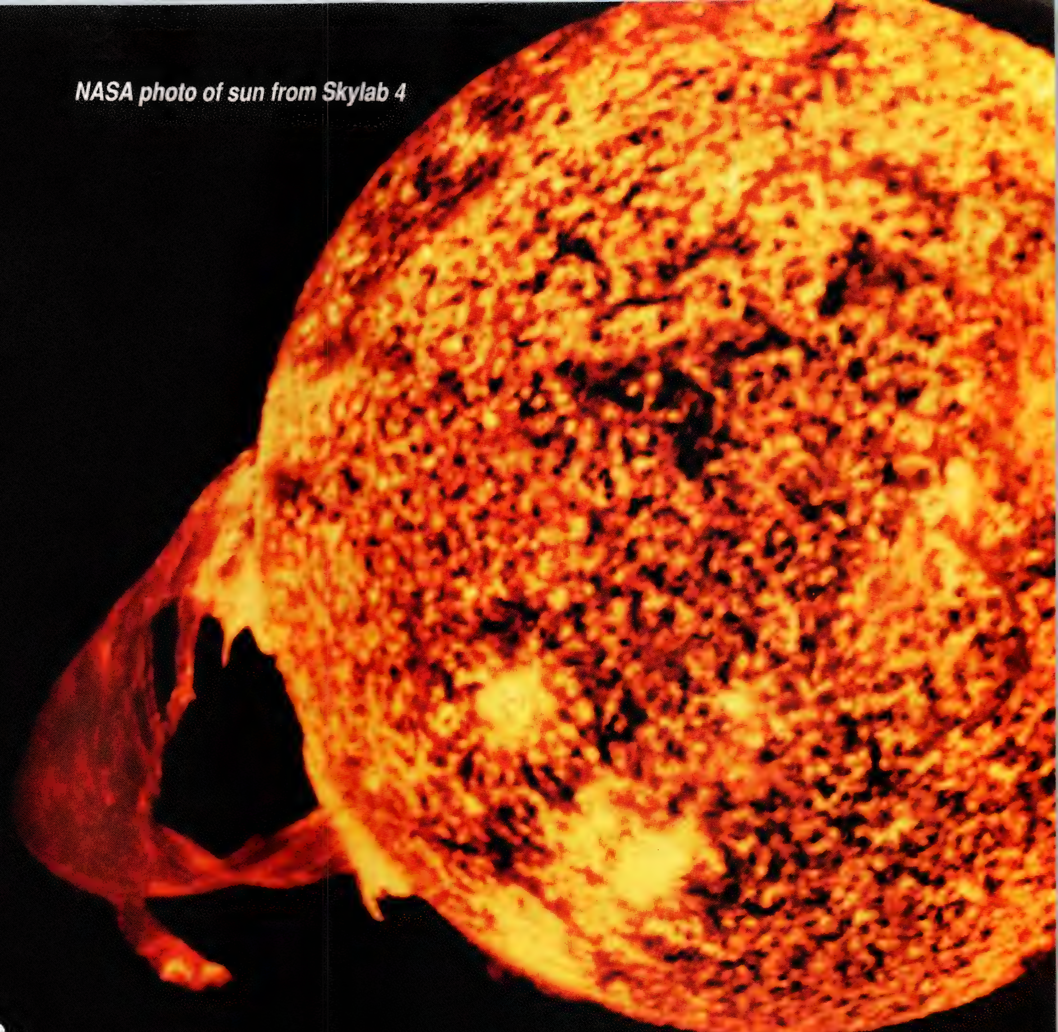
(c) entity input3_orand3 (implied memory)

2. THE UNIQUE FEATURES of VHDL can simplify creation of memory in logic design, or can produce memory when you don't want to. A 3-input OR-AND function can be written to contain no memory (a). Omission of the second ELSE statement would cause z to be synthesized as a signal with memory in the form of a latch (b). If both ELSE statements are omitted, a second memory element is added (c).

In Figure 1, for example, the performance of the magnitude comparator U5 (component mag16_comp1) determines the rate at which incoming data words can be processed. Comparison is complete when the load_peak output (mc1_out2) is true (when in_data2 is greater than peak_value) and the peak-value register (U2) is enabled to capture in_data2 as the new peak value on the clock's next rising edge. The time delay needed for the comparison determines the minimum feasible clock cycle. The design also requires a zero hold time in the peak-value register to ensure capture of the new peak value on the next clock edge. This is because the stored-input register, U1, captures a new input value on the same rising clock edge. The circuit compares the new peak value with subsequent input words, and updates it if its value is exceeded.

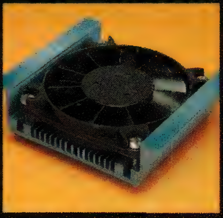
Therefore, synthesizing magnitude comparator U5 and mapping it to a target PLD requires the best possible performance. This is done by describing U5 in a structural format that dictates the manner in which it's to be implemented. That is, you should define U5 as a structural connection of lower-level VHDL components, or primitives. In this way, it can be implemented as fast, parallel carry-look-ahead arithmetic circuits, instead of slower, ripple-carry type circuits that are frequently synthesized from behavioral descriptions.

The other magnitude comparator, component U6 (mag16_comp2), isn't necessarily as speed-critical as is U5 because the alarm test needn't be made in each cycle. In fact, the alarm comparison check can afford to take two or more clock cycles (in which the peak value is stable) to determine if the alarm value was exceeded. Furthermore, it's okay if the peak value

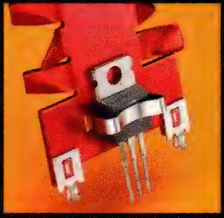

NASA photo of sun from Skylab 4

We cool the hot spots around the world.

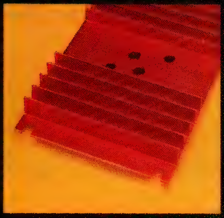
We cool the whole wide µP world.



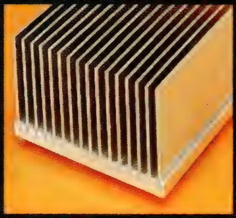
You get a world of stamped designs.



More extrusions than anyone—anywhere.



The higher the power, the more we can help.



For the full range of possibilities in cooling semiconductors, you need to talk to Aavid Engineering. No one offers you more choices. *No one.*

More product choices. For starters, we offer you over 3000 extruded and 500 stamped designs—all tooled. There's a full range of bonded fin, liquid cooled and cast products. From Intel's Pentium™ µP to DEC's Alpha, we have heat sinks for every µP. Nobody else comes close. *Nobody.*

More ways to attach. Snap on. Slide on. Plug in. We give you more *quick,* labor saving methods for mounting. Devices to heat sinks. Heat sinks to boards. *More than anyone.*

More design capabilities. We offer the world's best solutions for packaging high power density electronics. With the most advanced engineering team ever assembled, we can resolve any thermal management challenge—and deliver state-of-the-art solutions.

Call for immediate help— wherever you are around the world. Or send for literature.

One Kool Path
Laconia, NH 03247-0400
TEL: 603-528-3400
FAX: 603-528-1478

Also Santa Ana, CA, England and Singapore

AAVID™
AAVID ENGINEERING, INC.

WE LEAD THE THERMAL MANAGEMENT WORLD

Pentium is a registered trademark of Intel Corp.

See us at Wescon Booth #2640-2643

READER SERVICE 170

READER SERVICE 98

The realms of our success.

knürr
excellent quality world-wide

KNÜRR USA Inc. · Headquarters · 1890 North Voyager Avenue · Simi Valley · CA 93063 · Tel. (8 05) 5 26 - 77 33 · Fax (8 05) 5 84 - 83 71

AUSTRALIA (02) 4 39 - 60 78, **AUSTRIA** (1) - 970 22 - 0, **BELGIUM** 03 - 3 26.02.99, **BRASILIA** (0152) 63 - 2444, **CZECH REPUBLIC** 0 69 - 23 31 58,
DENMARK 42 91 40 88, **FINLAND** 9 14 - 434 600, **FRANCE** (1) 43 77 85 85, **GERMANY** (0 89) 4 20 04 -0,
HUNGARY (06 1) 2 83 - 03 78, **INDIA** 2 12 79 01 21 - 24, **ISRAEL** 03 - 647 - 33 31, **ITALY** (02) 95 34 30 80, **JAPAN** 04 26 - 23 - 12 11,
NETHERLANDS 0 76 - 42 29 22, **NORWAY** 22.19.89.00, **PORTUGAL** 01/3 46 90 65, **SINGAPORE** 2 71 - 08 00,
SOUTH KOREA (02) 8 95 - 75 64, **SPAIN** 91 - 8 89 89 61, **SWEDEN** 08 - 6 26 71 00, **SWITZERLAND** 01 - 8 25 07 07, **UNITED KINGDOM** 04 80 - 49 61 25

LISTING 2: VHDL BEHAVIORAL DESIGN FILE

```
–16 bit magnitude comparator 2
–Cypress WARP Native VHDL PLD Compiler
–File Name : mag16_comp2.vhd
–Author: Al Graf

use work.cypress.all;
use work.rtlpkg.all;
use work.bv_math.all;

entity mag16_comp2 is                            –entity declaration
      port(a, b: in bit_vector(0 to 15)
           lesser, greater: out bit);
end mag16_comp2;

architecture one of mag16_comp2 is               –architecture of entity
begin
          mag_comp:process                       –process statement
          begin
              IF (a > b) THEN greater <= ’1’; lesser <= ’0’;
                        ELSE lesser <= ’1’; greater <= ’0’;
              end IF;
          end process;
end;
```

gets updated in the next cycle before U6 can respond, because at some point it will stabilize long enough for U6 to test the value against the alarm limit. So you may prefer a behavioral description for U6, because it simplifies the design description and allows the compiler the greatest latitude for synthesis and fitting in the target PLD.

By now it should be fairly obvious why knowing when and where to use each VHDL design style is so important. In summary, to preserve the performance of speed-critical portions of a design, you may want to use structural techniques. But where clarity and compactness of the design description and a shorter design time are key factors, behavioral techniques are most useful.

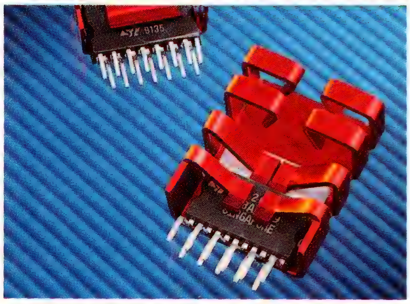
You can create synchronous registered memory elements in logic designs with the process structure. The description of a synchronous registered 2-input AND function has an entity port statement that shows Boolean input ports and a bit-type clock input port *(Listing 3)*. Note that in the process called synch_and, it's the "wait until..." statement that's the clock synchronization statement. In other words, the process is suspended until the specified signal change occurs, so the signal assignments after the statement are active and executed sequentially on each rising edge of "clock."

The registered-logic example illustrates one of the unique features of VHDL that can simplify creation of memory in logic designs—or create memory when you don't expect or want to do so *(Fig. 2a)*. First, understand that it's recommended practice to always include an ELSE statement in the IF implementation. This ensures that the affected output signal is defined for all input conditions.

For instance, in Figure 2, omitting the ELSE statement of the outer "IF-THEN-ELSE" construct in the process "orand3" requires the synthesis tool to create a memory element (implied memory). This element saves the last defined value of the output signal for those input conditions in which the output isn't defined in the IF-THEN statement (through absence of the ELSE portion of the statement).

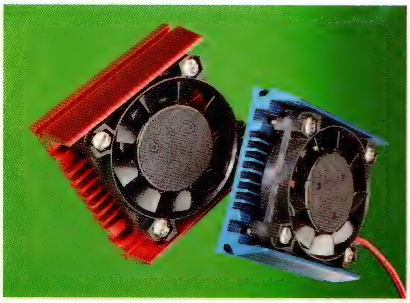
You can use this characteristic of VHDL semantic interpretation to create functions with memory. Omitting the last ELSE in the process orand3 would cause z to be synthesized differently *(Fig. 2b)*. In that case, it would be created as a signal with memory in the form of a transparent latch that directly replaces the AND gate in the previously synthesized entity. This implied memory saves the last value of z until the next occurrence of the condition (c = 1) that satisfies the IF-THEN statement.

The implied memory feature of VHDL eases memory-element (transparent latch) implementation and prevents inadvertent creation of undefined logic states. But it also can result in the creation of additional registered logic that the designer doesn't know about. This can result in poor



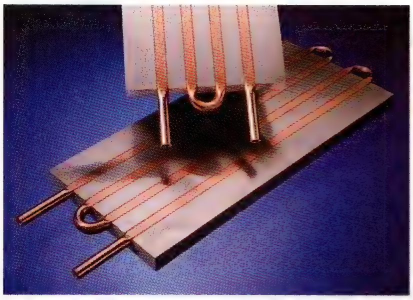
Heat sinks cool Multiwatt® ICs

Low-cost heat sinks cool Multiwatt and similar ICs. Self-locking design cuts IC assembly costs, eliminates hardware. Unique design holds ICs securely for top thermal performance. Slim and light, they take minimum board space. Low/medium power.
READER SERVICE 171



Fan/heat sinks cool Pentium™

New fan/heat sinks cool the Pentium, Alpha, Intel 80486, Motorola 68040, etc. Bidirectional, its shrouded sides maximize cooling capacity. The low profile, as little as 0.650" high, saves valuable space. Three sizes mount on 17X17, 19X19, 21X21 PGAs.
READER SERVICE 172

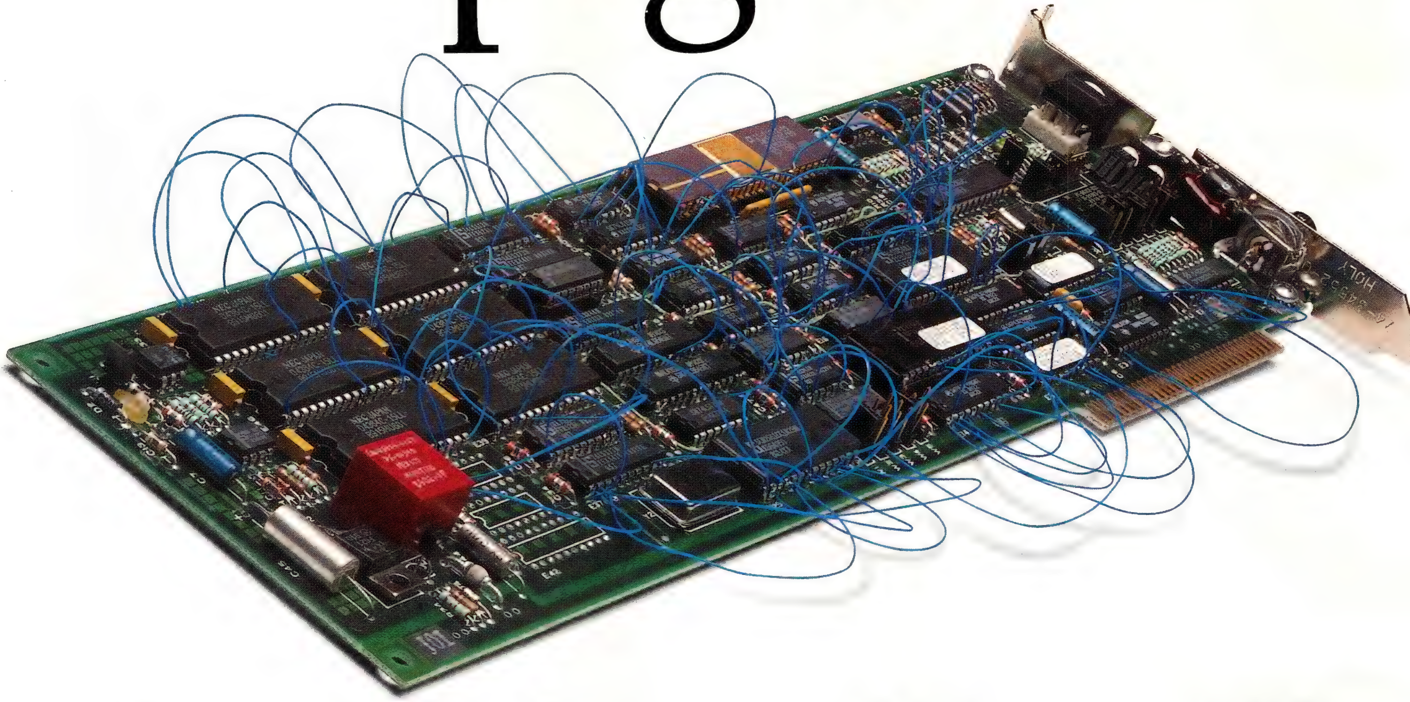


Hot concept in cold plates

New *Hi-Contact*™ liquid-cooled cold plates cool high power density electronic devices. They remove over 15% more heat, greatly reducing junction temperature. For cooling the most demanding high heat density IGBTs, other power modules.
READER SERVICE 173

AAVID ENGINEERING, INC.
One Kool Path, Laconia, NH 03247-0400
TEL:603-528-3400 FAX:603-528-1478

Hold The Spaghetti

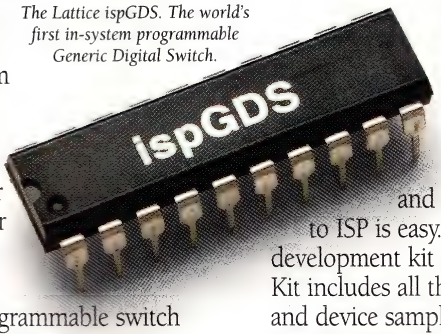


Re-route signals on your PCB using ISP™!

Lattice isp™ On Board

Make the switch to Lattice's revolutionary ispGDS™. In-system programmable Generic Digital Switch devices give you the power to re-route signals on your p.c. board without mechanical switches, jumpers or bogus blue wires.

The Lattice ispGDS. The world's first in-system programmable Generic Digital Switch.



7.5ns ispGDS devices combine a programmable switch matrix with in-system programmability (ISP) to quickly implement and change p.c. board connections. With ispGDS devices, signals can be re-routed under software control through a simple 5V, 4-wire serial programming interface.

ISP technology makes system design and manufacturing a breeze. With ISP, system designers create hardware which can be reconfigured in-system to meet a variety of applications.

This flexibility dramatically reduces time-to-market and lowers manufacturing costs.

Lattice offers a complete line of ISP devices, from ispLSI® High-Density PLDs, to the 7.5ns ispGAL22V10 and ispGDS devices. And switching to ISP is easy. Lattice offers a complete ISP development kit for only $99. The ispStarter™ Kit includes all the design software, ISP cables and device samples you need to complete your first ISP design, quickly and easily.

So hold the spaghetti and order in-system programmability. **Call 1-800-327-8425** or FAX 503-681-3037 today for a **free ispGDS sample and data sheet**. Ask for information packet 320.

isp
Starter Kit
Includes:
Software,
Samples,
ISP Cable
Only $99

Lattice™
The Leader in ISP™ PLDs

ISP, ispGDS and ispStarter are trademarks of Lattice Semiconductor Corp. ispGAL and ispLSI are registered trademarks of Lattice Semiconductor Corp. All brand or product names are trademarks or registered trademarks of their respective holders.

Corporate Headquarters: Tel: (503) 681-0118, Fax: (503) 681-3037 • **France:** Tel: (33) 1 41 14 83 00, Fax: (33) 1 41 14 83 01 • **Germany:** Tel: (49) 8165-9516-0, Fax: (49) 8165-9516-33 • **Hong Kong:** Tel: (852) 529-0356, Fax: (852) 866-2315 • **Japan:** Tel: (81) 3-5820-3533, Fax: (81) 3-5820-3531 • **United Kingdom:** Tel: (44) 753-830-842, Fax: (44) 753-833-457

READER SERVICE 100

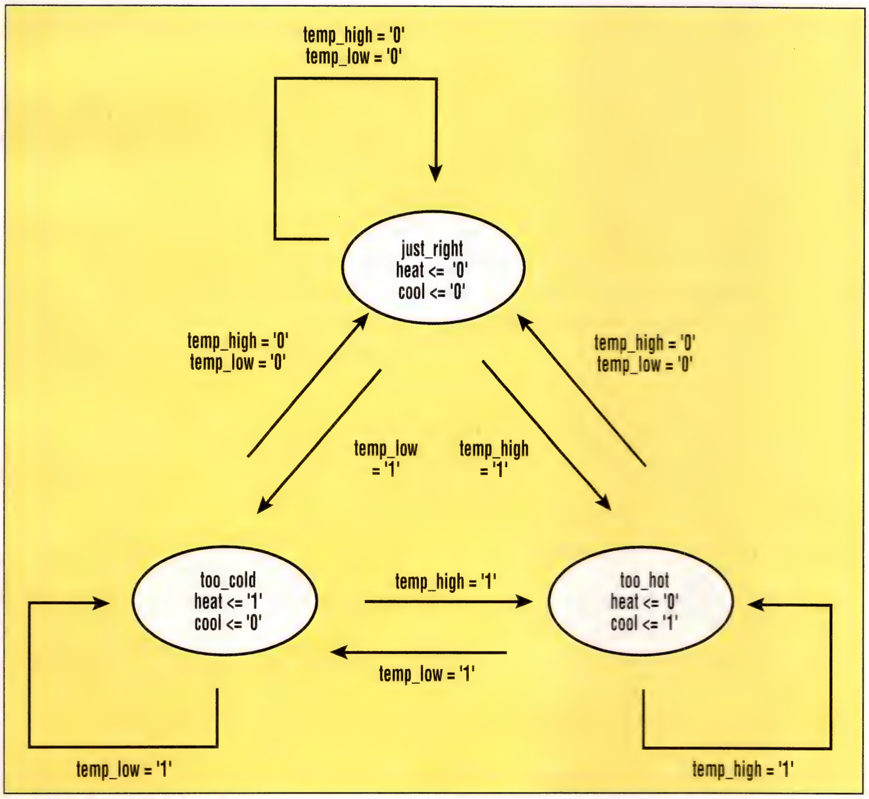
fitting of the logic synthesized for a PLD, because registers are frequently a limited commodity.

For example, consider the situation when the ELSE statement of the nested (inner) IF-THEN construct also is omitted. The logic synthesized now includes an additional memory element (another latch) between the output of the OR gate and the output latch that was created in the earlier example by the omitting the outer ELSE *(Fig. 2c)*. This new inner latch saves the output of the OR function for all cases not specified in the associated IF-THEN statement.

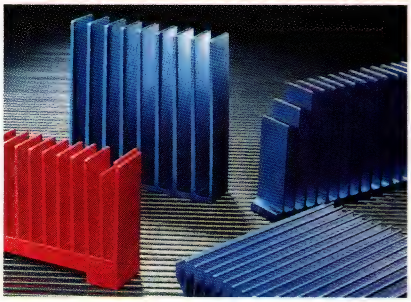
In the functional simulation, output y of the OR gate transitions to 1 when the IF-THEN describing the OR gate is initially satisfied (a = 1 or b = 1), and holds that value until the condition is met again. For subsequent occurrences of the triggering conditions, there's no output change at y because y is already 1. Thereafter, when the outer IF-THEN is satisfied (c = 1), the 1 state at y is passed to output-port z. It's then stored on z when the second (outer) latch is closed upon input port c returning to 0. In subsequent events when the second latch is opened, no change occurs on output-port z because the output of the first latch at y never changes.

It's clear, then, that you have to be careful when describing complex conditional logic in VHDL. You must avoid inadvertently creating implied memory, which can dramatically reduce logic efficiency in a PLD implementation by consuming additional resources to implement the implied latches. The presence of inadvertent implied memory typically will be revealed by incorrect operation during functional simulation. However, if the additional memory prevents the design from fitting in a target device that otherwise could accommodate the correct design, then the incorrect design may not be detected until a larger, more costly target device is mapped and simulated.

A valuable aid in quickly identifying functional problems, like inadvertent implied memory, is to be able to simulate the VHDL description before synthesis. This validates the design for correctness, thereby avoiding the time-consuming step of mapping to a target device prior to confirming design functionality.



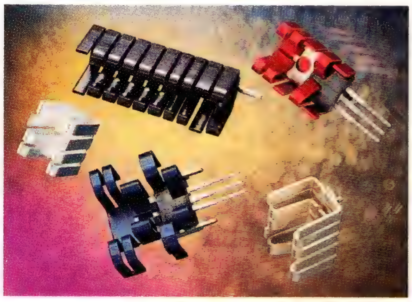
3. TWO INPUTS drive the state diagram controlling a furnace/air-conditioner system. The inputs (temp_high and temp_low) are connected to sensors that detect room temperature.



High fin density: peak cooling

New aluminum heat sink extrusions with high fin density offer maximum cooling in minimum space. Maximum industry fin-height-to-fin-spacing ratio *used to be* 6:1. New technology from Aavid extends it to 8:1, 10:1 and up. Ask our engineers for design help.

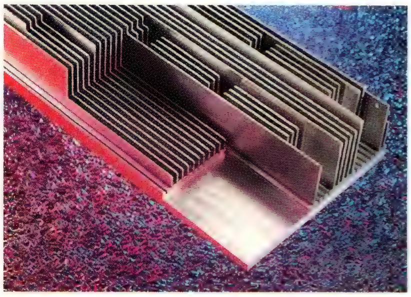
READER SERVICE 174



Plug-in heat sinks cool TO-220s

Compact heat sinks for TO-220s plug in quickly. Cut labor costs by eliminating nuts and bolts. Fins form spring action clips that hold semiconductors securely for superior thermal performance. Small footprint (as little as 1/2" sq) saves valuable space.

READER SERVICE 175



Bonded fins: 2-3X more cooling

Bonded fin heat sinks offer up to 3X the cooling of equal sized extrusions due to more surface area/inch^3. Existing widths of 1.25 to 17-in. are ideal for high current IGBTs, other power semis. No tooling costs on existing sizes. Prototype in days, not weeks.

READER SERVICE 176

AAVID ENGINEERING, INC.
One Kool Path, Laconia, NH 03247-0400
TEL: 603-528-3400 FAX: 603-528-1478

LISTING 3: SYNCHRONOUS REGISTERED 2-INPUT AND FUNCTION

```
use work.cypress.all;                         –library declarations
use work.rtlpkg.all;

entity synch_input2_and1 is                   –entity declaration

    port(a,b:in boolean;                      –port statement
            clock:in bit
            z:out boolean);

end synch_input2_and1;

architecture one of synch_input2_and1 is     –architecture "one" of
                                              –entity synch_input2_and1
begin
    synch_and:process                         –synchronous process

    begin

        wait until clock = '1';

        z <= a and b;

    end process;

end;
```

VHDL source-level simulation, including interactive debug, is available in Cypress's UltraLogic Warp3 PLD design tool. You can expect that most leading-edge VHDL PLD design tools will offer this capability, because it shortens the design implementation/validation cycle.

Because PLDs often are used as finite-state-machine elements, syntax for the creation of conditional state-transition logic is a key element of HDLs used for PLD design. VHDL provides various methods for creation of conditional state-machine-transition logic, including the IF-THEN-ELSE construct mentioned above, and the case statement. The case construct, like the IF-THEN-ELSE statement, provides for conditional signal assignment and must be used inside a process structure.

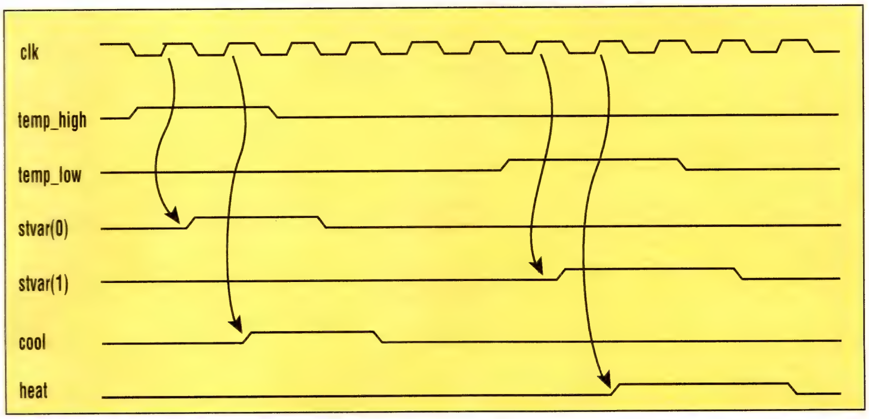
A simple state machine that controls a furnace/air-conditioner system has two inputs that are connected to sensors which detect room temperature *(Fig. 3)*. If the temperature is in the acceptable range, defined to be between 68° and 72°F, both the inputs (temp_high and temp_low) are low, or 0. If the room temperature exceeds the maximum acceptable threshold setpoint (72°), then input temp_high is high, or 1. But if the temperature falls below the minimum acceptable threshold (68°), input temp_low is high, or 1. It's assumed that the threshold points are set so that temp_high and temp_low can never both be high. The outputs of the entity furnace_controller1 are "heat" and "cool," which when high, turn on the furnace or the air conditioner.

The VHDL description of the controller has an entity/architecture pair that uses a process with a case statement incorporating IF-THEN-ELSE constructs to implement the state machine *(Listing 4)*. The design employs a VHDL feature called enumerated types, which allows the data type used for the state variable (stvar) to be defined as alphanumeric elements instead of as a bit_vector type. This makes the design more readable. It also provides for state encoding that can be easily modified or selected by the compiler for the most efficient implementation. In other words, the compiler can perform state minimization and assign numeric state values in the most efficient manner for the target PLD.

For example, MAX-architecture complex PLDs (CPLDs) devices include a limited number of dedicated product terms for each macrocell. They generally require slower expander terms for most logic functions, which may degrade performance. However, a one-hot encoding scheme can avoid use of the slower expander terms. That's because it dedicates a register to each state, and implements a state word for which only one output register would be active or TRUE for each machine state. Though the one-hot approach reduces the logic required to decode the state transitions for each register (thereby reducing the number of product terms required), it requires more registers (one per machine state). This is in contrast to a binary encoded scheme, which would require only $\log_2$ (number of machine states) registers.

The simulator output for the state-machine design indicates that, based on the choice of the target PLD, the compiler has chosen a binary-encoded scheme *(Fig. 4)*. To simplify state-encoding choices for the user, the ideal PLD compiler should accept user-defined synthesis directives for speed- or density-optimized implementations. And, based on the user directive, it should choose the best state-encoding scheme for the target PLD. In the absence of such flexibility, most compilers allow you to select directly the best encoding scheme—binary, one-hot, or Grey—based on your knowledge of the target-device architecture and design objectives.

In our furnace-controller example, the compiler implemented a binary-encoded state vector in two PLD-out-



4. SIMULATION waveforms for the simple controller in Figure 3 indicate that, based on the target PLD, the compiler has chosen a binary-encoded scheme for the design.

TO MEET THE TOP NAMES IN TV WALK THIS WAY

(899 km)

There's only one location that attracts key decision makers from all sectors of the broadcasting industry. A place you'll find such major names as Sony Broadcast, Tektronix, Vistek, NTL, Quantel, BTS, Panasonic and Thomson among a host of others. And a place where participants from 106 countries look forward to a comprehensive programme, recognised internationally as the best platform for the latest developments and trends. Don't miss the very best TV, cable, satellite and multi-media show on earth. The Montreux International Television Symposium – 8-13 June 1995.

MONTREUX 95

READER SERVICE 235

put macrocell registers—stvar(0) and stvar(1)—used as buried registers. It also used two additional device-output registers for the control output ports "heat" and "cool." Binary encoding requires two registers to encode the three states: just_right, too_hot, and too_cold. Note that in the simulation output shown in Figure 4, the output ports "heat" and "cool" are activated one cycle after the state vector changes. This is because the state vector must be decoded before the outputs can be assigned.

There are a number of simple behavioral-coding techniques you can use to wring the highest logic efficiency out of the targeted PLD. Because registers often are the limiting factor in design fitting, you should take care to code behavioral descriptions to minimize the number of registers needed, which allows you to use the least-expensive PLD.

In state-machine designs for PLDs, attention to register synthesis can considerably increase logic efficiency. For instance, the design for the furnace controller shown in Listing 4 would usually be synthesized into four registers. The stvar signal will require two buried registers. Meanwhile, the control outputs, because they're within the synchronous process furnace1, will require output registers to implement the "heat" and "cool" signals.

As shown in Figure 4, the registered "heat" and "cool" outputs change state one cycle after the transition of stvar. This indicates an additional pass through the PLD for decoding of stvar to determine the next state of the output signals.

In a PLD such as the 22V10, the stvar buried registers would consume I/O macrocells, making them unavailable as either outputs or inputs for other logic that also might be included in the device. More efficient state-machine PLDs, such as the Cypress CY7C335 and FLASH370 family of CPLDs, can fit buried-state registers without loss of I/O macrocells, because they contain buried macrocells dedicated to the purpose. Moreover, the CY7C335 can bury 50% of its output macrocells and still preserve use of the associated pins as inputs, making it even more efficient for state-machine implementation.

However, let's say that availability of an excess inventory of 22V10s dictates that we try to fit our state-machine design as efficiently as possible into this device. We should use the minimum number of I/O macrocell registers, thereby saving as many inputs and outputs as possible for other logic.

LISTING 4: FURNACE/AIR-CONDITIONER CONTROLLER

```
use work.rtlpkg.all;                                                –library declaration

entity furnace_controller1 is                                       –entity declaration
    port (temp_high, temp_low, clk:in bit;                            –port statement
                   heat,cool:out bit);
end furnace_controller1;

architecture one of furnace_controller1 is

    type state_type is (too_hot, too_cold, just_right);             –enumerated states

    signal stvar:state_type;                                        –local signal declaration

    begin
        furnace1:process                                            –state machine process
        begin
        wait until clk = '1';

        case stvar is

        when just_right =>

            heat <= '0';                                            –output assignment
            cool <= '0';

                IF (temp_low = '1') THEN stvar <= too_cold;
                ELSE
                     IF (temp_high = '1') THEN stvar <= too_hot;
                     ELSE stvar <= just_right;
                     END IF;
                END IF;

        when too_cold =>

            heat <= '1';                                            –output assignment
            cool <= '0';

                IF (temp_low = '0' and temp_high = '0') THEN stvar <= just_right;
                ELSE
                     IF (temp_high = '1') THEN stvar <= too_hot;
                     ELSE stvar <= too_cold;
                     END IF;
                END IF;

        when too_hot =>

            heat <= '0';                                            –output assignment
            cool <= '1';

                IF (temp_low = '0' and temp_high = '0') THEN stvar <= just_right;
                ELSE
                     IF (temp_low = '1') THEN stvar <= too_cold;
                     ELSE stvar <= too_hot;
                     END IF;
                END IF;

        end case;

        end process;
end;
```

The Speed Will Blow Your Mind. The Price Won't Blow Your Budget. The Competition Will Blow Its Stack. Again.

Introducing Two New Additions To The World's Fastest Family Of 64-Bit Workstations.

ALPHA GENERATION™ You don't stay the leader in workstation performance by resting on your CPUs. You do it by creating a new generation of rockets like the new DEC 3000™ Model 900 deskside and Model 700 desktop workstations. Powered by the Alpha AXP™ microprocessor, they're not just the fastest machines for the money. But the fastest. Period. Giving you true 64-bit computing for power-hungry applications, sizzling 2D and 3D graphics performance, faster data analysis and shorter design cycles. As well as access to a portfolio of more than 5000 applications, including all the ones you really need. And if that excites the power user in you, check out the easily upgradable Model 600, now the most powerful workstation for under $20,000.

> "With these workstations based on Alpha AXP chip technology, Digital continues to lead in performance and price/performance."
>
> Dominic Ricchetti, Director
> Workstation Research, Dataquest®

The New DEC 3000 Model 900 Deskside

	DEC Model 900	HP 735/125	IBM 59H	SGI Indigo2XZ
SPECfp92	264	201	251	97
SPECint92	189	136	123	88
ENTRY PRICE	$43,373	$39,995	$74,850	$28,500

The New DEC 3000 Model 700 Desktop

	DEC Model 700	HP 735/125	SGI Indigo2XZ	IBM 3BT	SUN 20/61
SPECfp92	231	201	97	205	103
SPECint92	163	136	88	114	89
ENTRY PRICE	$27,698	$39,995	$24,500	$33,300	$17,995

So pick up the phone and find out more. Because our workstations are guaranteed to blow you away. Again.

CALL 1-800 DIGITAL

Putting Technology To Work digital™

JCW © Digital Equipment Corporation, 1994. The DIGITAL Logo, the AlphaGeneration Logo, Alpha AXP, and DEC 3000 are trademarks of Digital Equipment Corporation. Dataquest is a registered trademark of Dataquest, a company of the Dun & Bradstreet Corporation. Screen image courtesy of Parametric Technology Corporation.

A revised VHDL behavioral description will cut the register requirement in half *(Listing 5)*. Here we see the states just_right, too_hot, and too_cold explicitly encoded using constant declarations, which allows the state vector registers to do double duty as the output control ports "heat" and "cool."

The design description removes the "heat" and "cool" signal assignments from the synchronous process containing the case statement. It creates a separate, independent combinatorial process, called output1, that assigns appropriate bits of the state vector to the outputs. This means that the value of the state vector will create the appropriate control outputs, "heat" and "cool," for the states in which the furnace and air conditioner should be activated.

This approach has at least four benefits. The first is a reduction in the number of macrocell registers needed to implement the logic, which makes more device outputs available for fitting other logic. The compiler merges the state-register function with the output-control function.

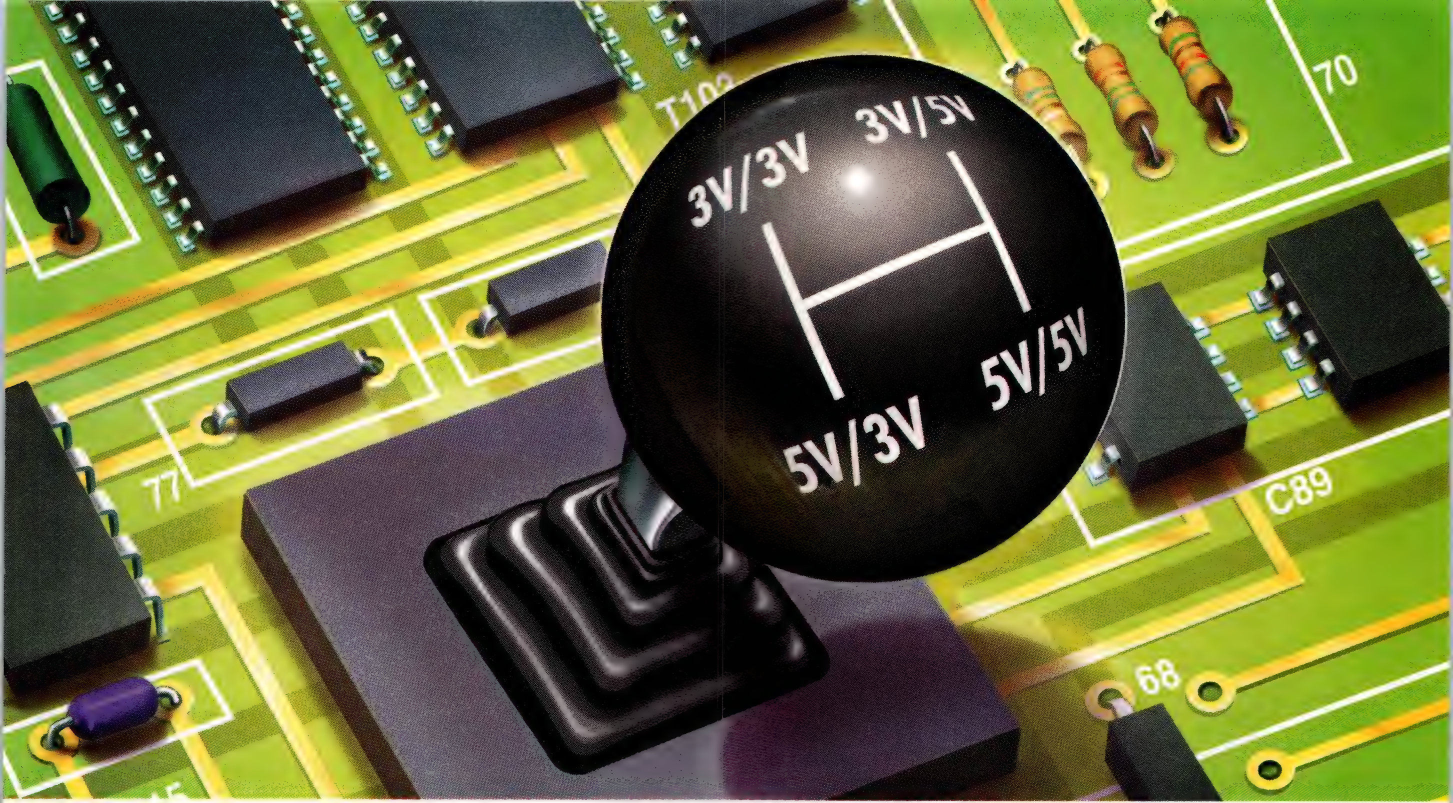
Another benefit is derived from the fact that the separate process (output1) is executed in parallel with the state-machine process (furnace1). Process output1 makes the "heat" and "cool" output-signal assignments in the same cycle in which the state change occurs, removing the one-clock-cycle delay required for updating the outputs in the previous design *(Fig. 4, again)*. If you compare the simulation for the initial design with that for the more register-efficient design, you can see the impact of concurrent processes *(Fig. 5)*.

The third benefit is that the code for the state-machine process (furnace1) now is independent of the actual output port names "heat" and "cool" defined in the entity declaration. This makes the process self-contained and portable. Now you can incorporate the working state-machine process, without modification, into any other architecture/entity pair by assigning signals to new output port names in a concurrent process analogous to process output1 in the design of Listing 5.

A fourth benefit is that in the more-efficient design of Listing 5, you can easily modify the port assignments by changing a single statement in the output assignment process (output1).

LISTING 5: REGISTER-EFFICIENT CONTROLLER

```
use work.rtlpkg.all;                                                  —library declaration

entity furnace_controller2 is                                         —entity declaration
    port (temp_high, temp_low, clk:in bit;                            —port statement
                  heat, cool:out bit);
end furnace_controller2;

architecture one of furnace_controller2 is

    signal stvar:bit_vector (0 to 1);                                 —local signal declaration

    constant too_hot:bit_vector (0 to 1):= "10";                      —constant declaration
    constant too_cold:bit_vector (0 to 1):= "01";
    constant just_right:bit_vector (0 to 1):= "00";

    begin
         furnace2:process                                             —state machine process
         begin
         wait until clk = '1';
         stvar <= just_right;

             case stvar is

             when just_right =>

                 IF (temp_low = '1') THEN stvar <= too_cold;
                 ELSE
                     IF (temp_high = '1') THEN stvar <= too_hot;
                     ELSE stvar <= just_right;
                     END IF;
                 END IF;

             when too_cold =>

                 IF (temp_low = '0' and temp_high = '0') THEN stvar <= just_right;
                 ELSE
                     IF (temp_high = '1') THEN stvar <= too_hot;
                     ELSE stvar <= too_cold;
                     END IF;
                 END IF;

             when too_hot =>

                 IF (temp_low = '0' and temp_high_'0') THEN stvar <= just_right;
                 ELSE
                     IF (temp_low = '1') THEN stvar <= too_cold;
                     ELSE stvar <= too_hot;
                     END IF;
                 END IF;

             end case;

         end process;

         output1:process                                              —output-signal assignment
                                                                      —process
         begin

             heat <= stvar (1);                                       —assign second bit of vector
                                                                      —to heat
             cool <= stvar (0);                                       —assign first bit of vector
                                                                      —to cool
         end process;
    end;
```



POWER SHIFTER.

H4CPlus™ Series Gate Arrays let you select the voltage scheme that meets your power and performance goals .

Thanks to continually shrinking gate length and other process improvements, today's ASIC chips are able to run at lower voltages without giving up much performance—3V vs. 5V. However, the transition to complete 3V systems must wait until standards catch up and components are produced in economical volumes. So, it's become a mixed-voltage world in which designers are incorporating into most new designs both 3V and 5V components.

Single-chip solution to mixed-voltage challenges

Motorola's H4CPlus CMOS gate arrays are designed to interface between 3.3V and 5V, minimize power dissipation, and support high frequency communications, while cutting system cost. *Now* designers can choose the voltage scheme that provides the performance required at the lowest power.

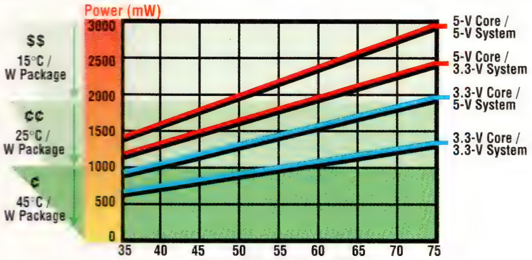
H4CPlus allows optimization of either the array core or I/O power—or both. Core may be 3.3V or 5V, I/O buffers 3.3V only, 5V only, or mixed.

H4CPlus Features

- 0.65 micron effective gate length.
- Triple layer metal.
- 21K to 296K available gates.
- Ball-Grid Array and QFP packaging.
- Chip-to-chip interface speeds exceeding 200MHz.
- Power savings up to 60% by running core and most of I/O at 3.3V, while retaining performance nearly equal to 5V designs.

Want to shift to an easier life in the mixed-voltage world? Send the coupon below, or write Motorola Ltd., European Literature Centre, 88 Tanners Drive Blakelands, Milton Keynes MK14-5BP, United Kingdom. Ask for data sheet H4CP/D.

Power Choices
Pick lower voltage supplies to reduce package cost.

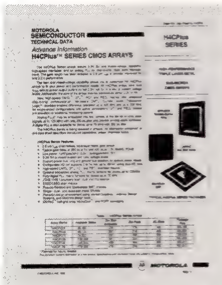


A Typical Application

MOTOROLA

Motorola and Ⓜ are registered trademarks of Motorola, Inc.

Motorola Ltd., European Literature Centre, 88 Tanners Drive, Blakelands,
Milton Keynes MK14-5BP, United Kingdom



Please send me H4CP/D data sheet. 647ED091994

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ______________________

Country ______________________

Volume production for under $10.

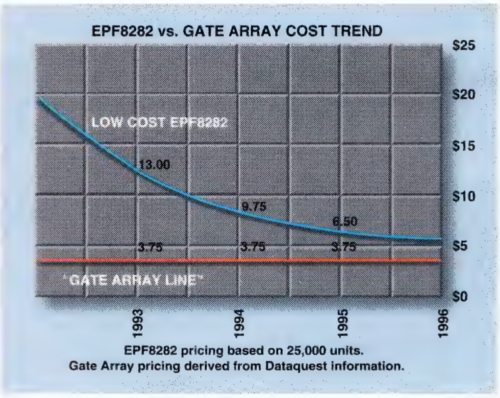
The gate array alternative.

At under $10, the FLEX EPF8282, a 2,500-usable-gate programmable logic device, is ideal for volume production. At this price, you may never need a gate array again.

FLEX *Ability* by design.

If you're considering a gate array for your next design, but would like to avoid long lead times and high NRE costs, then you're ready for FLEX programmable logic. With FLEX 8000 devices, you can make design changes on-the-fly, shorten your lead times and get to silicon faster. All FLEX 8000 devices feature predictable timing, thanks to our revolutionary FastTrack interconnect. It all adds up to what we call design FLEX *Ability*.

The EPF8282 provides all the options you need for high-volume production: 2,500 usable gates with 282 registers, up to 78 user I/O pins, multiple packaging options, including a 1-mm thick TQFP, and a choice of 5 V or 3.3 V versions. All the features you need—and at the right price.


EPF8282 vs. GATE ARRAY COST TREND

EPF8282 pricing based on 25,000 units.
Gate Array pricing derived from Dataquest information.

The complete solution.

Combine the EPF8282 with our easy-to-use MAX+PLUS II software and you have a complete design solution. And MAX+PLUS II works in your environment, interfacing with popular CAE tools, on PCs or workstations.

The Altera Advantage.

When you choose Altera for your programmable logic needs, you get more than speed and density. You also get technology leadership, the industry's easiest-to-use software tools, and comprehensive technical support. This is real value for your money. This is the Altera Advantage.

Call now for great pricing–and a FREE Applications Handbook.

The FLEX 8000 family of programmable logic devices offers densities up to 50,000 usable gates. For a free copy of our FLEX 8000 Handbook or more information on the EPF8282, call Altera today at 800-9-ALTERA (800-925-8372), or write to us at 2610 Orchard Parkway, San Jose, CA 95134-2020.

The ALTERA Advantage

© Copyright 1994 Altera Corporation. Altera, FLEX, MAX, and MAX+PLUS are registered trademarks, and MAX+PLUS II, FLEX 8000, FLEX *Ability*, FastTrack and EPF8282 are trademarks of Altera Corporation. All other trademarks are the property of their respective holders.

READER SERVICE 150

LISTING 6: 8-BIT COUNTER

```
synch_count:process
begin
    wait until clock = '1';
        IF (reset = '1') THEN count <= "00000000";      --resetting
        ELSE count <= count + "1";                      --incrementing
        end IF;
end process;
```

LISTING 7: 8-BIT COUNTER

```
asynch_count:process(reset, clock)
begin
    IF (reset'event) AND (reset = '1')
    THEN count <= "00000000";                       --resetting
    ELSE
        IF (clock'event) AND (clock = '1')
        THEN count <= count + "1";                     --incrementing
        ELSE count <= count;
        end IF;
    end IF;
end process;
```

This is in contrast to changing the assignment statements in each of the case-statement elements devoted to each state, as would be required in the original design description of Listing 4. For a complex state machine with many states, the latter approach can be tedious and prone to entry errors.

Many of the architectural features in PLDs are preconfigured. This minimizes the cost of the programming overhead, as well as the speed degradation that results from unneeded flexibility. For instance, the reset control for macrocell registers are typically asynchronous, which allows system reset at any time during operation. And the registers are usually served by at least one product term, which allows creation of the logic conditions for which reset should be initiated. You must make some acknowledgment of this reset operation when you write behavioral designs for such registers to make the best use of logic.

As an example, the behavioral description of an 8-bit synchronous counter has a reset condition that can be specified within the process that describes the counter's operation *(Listing 6)*. The process (synch_count) uses a (wait until clock = 1) statement and a conditional assignment statement to implement the counter description.

The point here is that because synchronous operation is indicated, an input term (not reset) will be synthesized as an extra input to every product term for each of the counter's eight bits. This ensures that when reset is TRUE, or 1, all eight counter outputs are forced to a LOW, or 0. Unfortunately, doing so consumes an extra input term for each product term at each output. None of this would be needed if the synthesis process took advantage of the dedicated reset product term, which asynchronously controls reset of the registers.

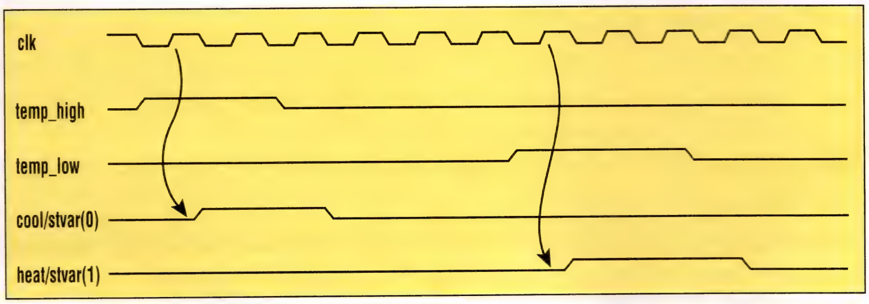
The correct way to code such a counter description is to invoke the asynchronous reset feature incorporated in most PLDs *(Listing 7)*. This approach makes use of a sensitivity list in an asynchronous process header, asynch_count:process(reset,clock), which causes the process to be evaluated whenever the reset input or the clock input changes. Then, placing the reset condition first in the following hierarchical IF-THEN sequential conditional-assignment statement makes the reset properly dominant.

Most complex PLDs dedicate a single product term to the reset and set of each macrocell register. This allows the AND of any set of device inputs to control the reset and set functions. Some CPLDs, like Cypress' FLASH370 family, provide additional flexibility by also allowing optional inversion of the product term's output, making it a NAND function and allowing the OR of any set of device inputs to initiate reset and/or set. This is done by a De Morgan transformation of the resulting NAND function to an OR function.

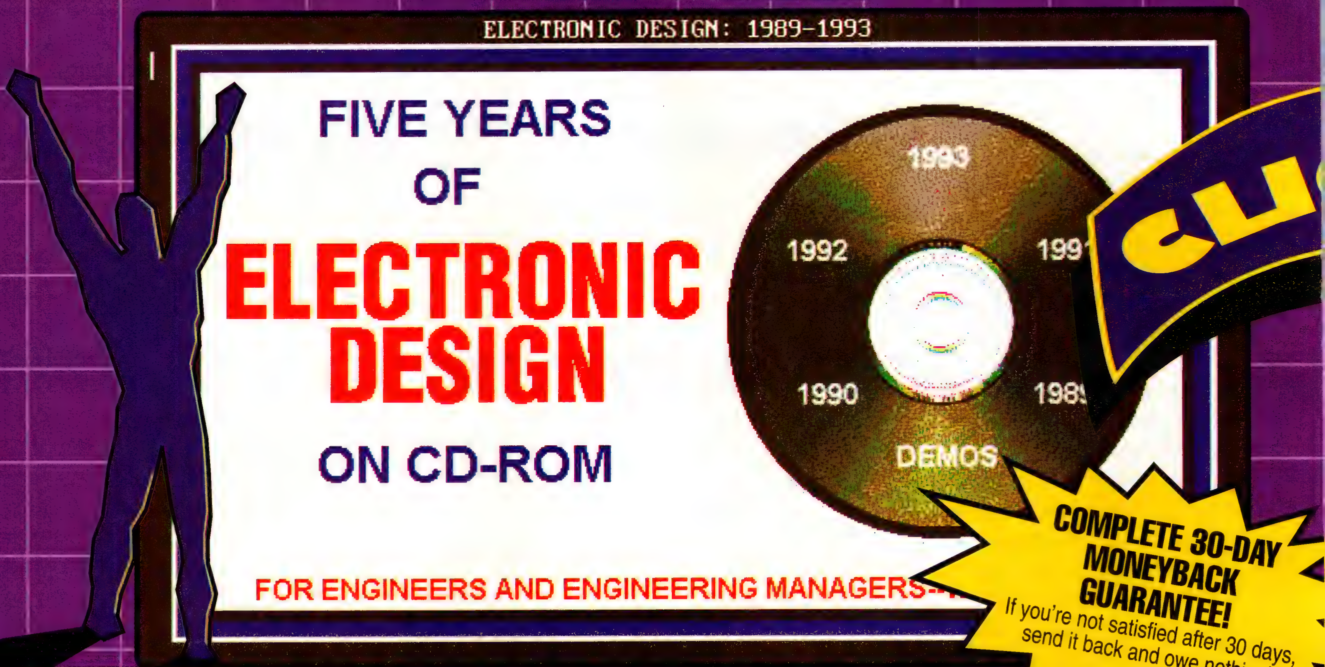
A compiler synthesizing logic for such a PLD should be able to invoke the OR-function capability for controlling set and reset by inverting the output of the product term and using the complement of the requisite inputs. This is more efficient than wasting a macrocell output by using its sum (OR) term and feeding the output back to create such a function. The latter, less efficient implementation is the only option available in a PLD without the NAND option on the reset and set product terms.

Synthesis of the behavioral design description of a binary compare or adder function calls for exclusive-OR (XOR) functions to implement the logic. You can implement XOR functions in the sum-of-products logic of general-purpose PLDs. This allows a simple binary compare to be implemented in one pass through the PLD, but requires a second pass through the device to implement the next XOR stage needed for a magnitude comparator or full adder. The second pass through the logic array will reduce the design's performance.

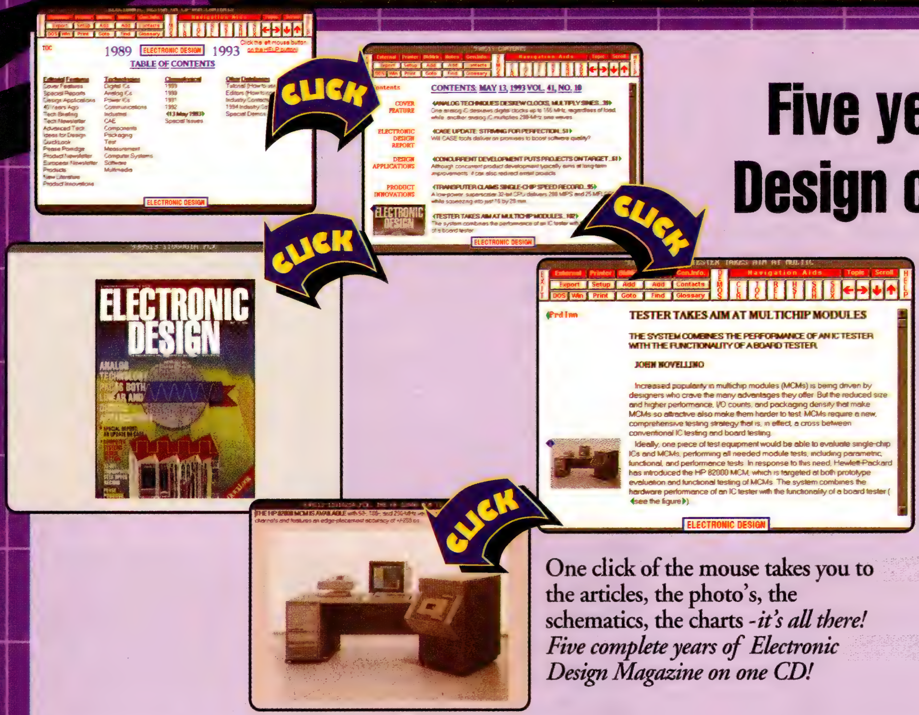
Some devices incorporate a dedicated exclusive-OR, thus allowing a full adder to be accomplished in a single pass through the device. The small additional gate delay associated with the dedicated XOR, which burdens every signal path for applications not needing the XOR, is acceptable because of the improved performance in arithmetic applications that need the extra XOR. An example of an XOR-



5. SIMULATION WAVEFORMS for the register-efficient controller version show the impact of concurrent processes in the revised controller design.


ELECTRONIC DESIGN: 1989-1993
FIVE YEARS
OF
ELECTRONIC
DESIGN
ON CD-ROM
FOR ENGINEERS AND ENGINEERING MANAGERS
1993
1992
199
1990
198
DEMOS
CLI

COMPLETE 30-DAY MONEYBACK GUARANTEE!
If you're not satisfied after 30 days, send it back and owe nothing!



TOC
1989 ELECTRONIC DESIGN 1993
Click the left mouse button on the HELP button
TABLE OF CONTENTS

Editorial Features	Technologies	Chronological	Other Databases
Cover Features	Digital ICs	1989	Tutorial (How to use
Special Reports	Analog ICs	1990	Editors (How to
Design Applications	Power ICs	1991	Industry Contacts
40 Years Ago	Communications	1992	1994 Industry
Tech Briefing	Industrial	13 May 1993	Special Demos
Tech Newsletter	CAE	Special Issues	
Advanced Tech	Components		
Ideas for Design	Packaging		
QuickLook	Test		
Pease Porridge	Measurement		
Product Newsletter	Computer Systems		
European Newsletter	Software		
Products	Multimedia		
New Literature			
Product Innovations			

Contents
CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE
ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...38
One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves.

ELECTRONIC DESIGN REPORT
CASE UPDATE: STRIVING FOR PERFECTION...51
Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS
CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...61
Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects.

PRODUCT INNOVATIONS
TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95
A low-power superscalar 32-bit CPU delivers 200 MIPS and 25 MFLOPS while squeezing into just 16 by 28 mm.

TESTER TAKES AIM AT MULTICHIP MODULES...102
The system combines the performance of an IC tester with the functionality of a board tester.

Prd Inn
TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

Ideally, one piece of test equipment would be able to evaluate single-chip ICs and MCMs, performing all needed module tests, including parametric, functional, and performance tests. In response to this need, Hewlett-Packard has introduced the HP 82000 MCM, which is targeted at both prototype evaluation and functional testing of MCMs. The system combines the hardware performance of an IC tester with the functionality of a board tester (see the figure).

Five years of Electronic Design complete on one CD

- *All the articles*
- *All the photographs*
- *All the schematics*
- *All the drawings*
- *All the editorials*
- *All the letters*

One click of the mouse takes you to the articles, the photo's, the schematics, the charts *-it's all there! Five complete years of Electronic Design Magazine on one CD!*

THIS CD-ROM, produced by the Editors of Electronic Design Magazine, contains five complete volumes - that's 124 past issues of Electronic Design Magazine. Presented in 16-color VGA, it's packed with more than 4,000 photos and graphics. All the articles, features, product reviews, product updates *(even product demos!)*, editorials, letters are included - everything electronics industry professionals expect from Electronic Design.

All of the information in this CD is made instantly accessible through a powerful Hypertext application called *Hyperwriter*™.

Hyperwriter™ makes the information on this disk instant accessible through hypertext links. Links made directly throug each topic (article) to pictures, illustrations, schematics, full glo saries, product demos, and contact names, plus past and subs quent related topics.

Specific topics are quickly located using the powerful searc features provided. Using a key-word or key word strings, you g a list of all related topics-*instantly.*

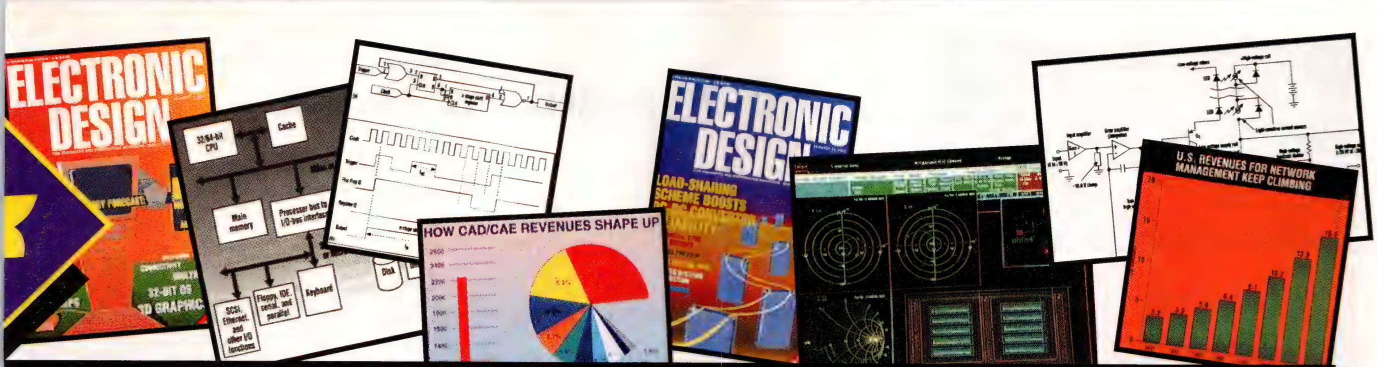
Instant comprehensive information. That's what this disk is a about.

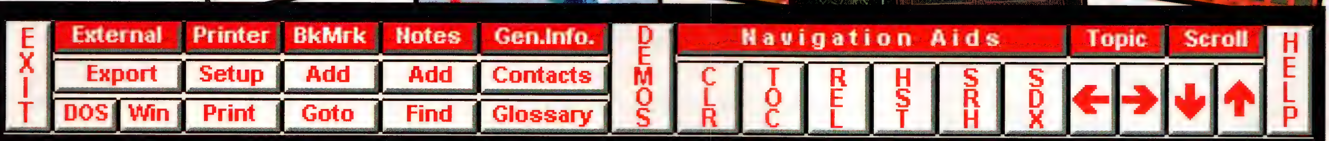
International phone orders call: *201-393-6060* • ***Inside USA:*** *800-829-9028-9am-5pm est.* • ***To order by fax:*** *201-393-0204*
To order by mail: *Send your order to: Electronic Design Magazine, 611 Route 46 West, Hasbrouck Heights, NJ 07604*

5 Years of Electronic Design Magazine on CD-ROM (1989-93)	**$295.00**	1 Year of Electronic Design Magazine on CD-ROM (1993)	**$95.00***

Network 1 & 5 year versions also available - call for details

** Upgrade to the 5 year version within 90 days and pay only $20*

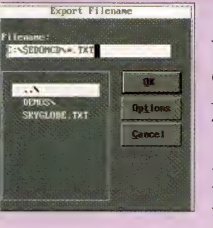

ELECTRONIC DESIGN
32/64-bit CPU
Cache
Main memory
Processor bus to I/O-bus interface
SCSI, Ethernet, and other I/O functions
Floppy, IDE, serial, and parallel
Keyboard
Disk
32-BIT OS
3D GRAPHICS
HOW CAD/CAE REVENUES SHAPE UP
ELECTRONIC DESIGN
LOAD-SHARING SCHEME BOOSTS
U.S. REVENUES FOR NETWORK MANAGEMENT KEEP CLIMBING



earn the backbone of the Electronic Design Magazine CD-ROM interface - the BUTTONBAR.

Powerful, hypertext-based commands let ou quickly and efficiently find, re-find, ink, make notations, leave bookmarks, xport, print, search, get product demos, nd even return to your operating system!

External - Life beyond this disk



```
Export Filename
Filename:
:\$EDOMCD\*.TXT
..\
DEMOS\
SKYGLOBE.TXT
```

The **Export** button will export any or all of an article based on your selection.

DOS & **Win**

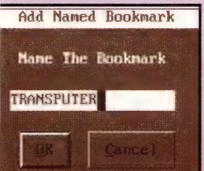
DOS brings you to the DOS prompt creen and **Win** takes you into Windows™ without quitting the application. These buttons make it easy for you to return to Electronic Design Magazine, where you left ff, without re-launching.

Printer Commands

Setup & **Print** - This feature allows ou to print articles, editorials, glossaries, illustrations, and even photos *(if our printer is capable)* directly from this D. Great source for reference.

Bookmarks and Notes

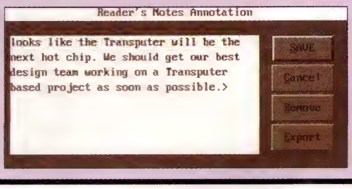
BkMrk - Bookmarks flag topics for future eference, just like using a bookmark in a real magazine. Mark a spot, and the bookmark is stored even if you quit.



```
Add Named Bookmark
Name The Bookmark
TRANSPUTER
```

GOTO brings you back to your bookmarks. Deleting them is just as simple.

Notes - Add and find your own notations. Notes stay until you delete them, even after ou quit.



```
Reader's Notes Annotation
looks like the Transputer will be the
next hot chip. We should get our best
design team working on a Transputer
based project as soon as possible.>
```

Gen. Info - Complete reference

Contacts - Company names, addresses, contact names, phone numbers- all of the information you need to follow up.

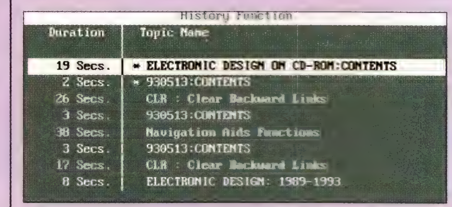
Glossary - Full article glossaries, provided by the Editors of Electronic Design magazine. The CD also comes with **WORD LINK**, which allows you to click on any word within the article and if it's in the glossary, the definition pops up. When you're done, a simple click and it's gone.

Navigation Aids - Magellan you're not, and you don't need to be!

All the aids you'll need to motor your way through this CD in no time flat.

CLR - *Clear Back Links* - Because every article you move to loads into RAM, this function allows you to clear articles you've finished. This frees up RAM for you to continue.

TOC - *Table of Contents* - Takes you directly to the Volume Table of Contents (the whole year) with special links provided to Issue T.O.C.



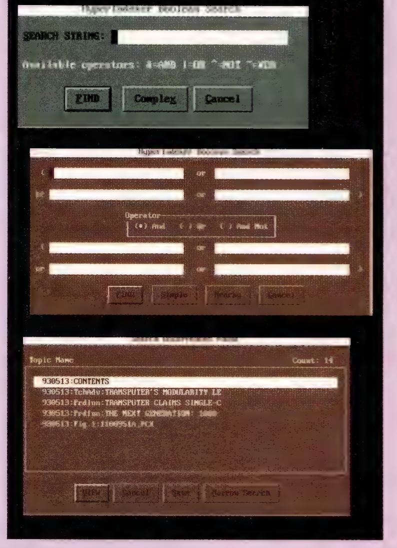
```
                History Function
 Duration   Topic Name

 19 Secs. | * ELECTRONIC DESIGN ON CD-ROM:CONTENTS
  2 Secs. | * 930513:CONTENTS
 26 Secs. |   CLR : Clear Backward Links
  3 Secs. |   930513:CONTENTS
 38 Secs. |   Navigation Aids Functions
  3 Secs. |   930513:CONTENTS
 17 Secs. |   CLR : Clear Backward Links
  8 Secs. |   ELECTRONIC DESIGN: 1989-1993
```

REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

HST - *Show-Related History* - Shows each topic visited during your current session and how long you were there, and then lets you return to previous topics.

SEARCH dialog boxes

Simple search (top), Complex Search (center), and Search occurances found (bottom).



```
SEARCH STRING:
```

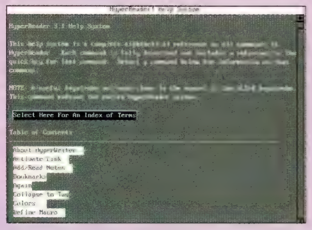
```
Topic Name                         Count: 14
930513:CONTENTS
930513:TchAdv:TRANSPUTER'S MODULARITY LE
930513:PrdInn:TRANSPUTER CLAIMS SINGLE-C
930513:PrdInn:THE NEXT GENERATION: 1000
930513:Fig 1:1100951A.PCX
```

SRH - *Search* - Conduct simple, complex or proximity indexed searches.

SDX - *Subject Index* - A hierarchical list of key subject areas compiled by the Editors of Electronic Design. The index also allows direct access to related topics.

HELP - Instant on-line help for all

Written in plain, easy to understand terms providing information for novice and pro alike. Available in any user screen.



MINIMUM SYSTEM REQUIREMENTS

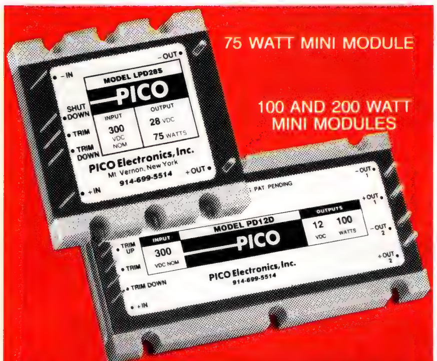
☞ 80386 PC or better

☞ VGA video card adaptor w/640 x 480 pixel resolution 16 colors.

☞ 1 meg ram

☞ MS-DOS Version 3.1 or later

PICO POWER



Single and DUAL
75,100,200
Watt
Power
Modules

- Dual Isolated Outputs (standard)
- Up to 100 VDC Output (standard)
- Fixed Frequency
- Parallel Operation
- Wide Input Ranges 18-380 VDC
- Regulated Outputs
- Continuous Short Circuit Protection
- Low Cost

Military Modules
- Meets 704D Input Specifications
- Environmental Testing Available
- MIL STD 883 • MIL STD 810 (Selected Screening)
- Operating temp. –55°C to +85°C
- Dual Outputs • Up to 100 VDC Output
- Hi-Temp Full Power Burn-In Available
- Special Output Voltages Available

Delivery—stock to one week

See EEM or send direct for Free PICO Catalog.
Call toll free 800-431-1064
in NY call 914-699-5514
FAX 914-699-5565

PICO Electronics, Inc.
453 North MacQuesten Pkwy., Mt. Vernon, N.Y. 10552

enhanced device is Cypress' CY7C335, which incorporates an XOR gate in each I/O macrocell. The XORs in this device also implement toggle-type register (T flip-flop) macrocell options.

Most PLD VHDL compilers are unable to perform architecture-specific synthesis, so they typically implement adders by expanding the XOR terms and synthesizing cascaded XORs (from product terms) in two logic-array passes. Ideally, however, your compiler should be smart enough to preserve the XORs in synthesis (for optimum performance when targeting a device containing dedicated XORs), but synthesize the function from product terms for those devices without dedicated XORs. Some tools provide a user-controlled option switch to preserve XORs, which can be set when targeting a device with dedicated XOR terms.

Implementing counters in PLDs with only D-type flip-flop macrocell registers consumes many extra product terms, because every counter state must be decoded for each counter output bit. This is necessary to hold a given output bit constant (pass the same state through the D register to the output) for the counter transitions in which no change is required on the given output.

Some PLDs, such as Cypress' FLASH370 family of CPLDs, contain registers that can be configured as D or T flip-flops. A counter implemented with T-type registers for each bit need only decode transitions for which a particular output bit must change. The result is that fewer product terms are required for the counter implementation, leaving more logic available to fit other counter-control logic.

Ideally, a VHDL compiler should be able to automatically synthesize counters and control logic with more efficient T-type registers when the targeted PLD offers such a register option. For example, Cypress's Warp Native VHDL Compiler performs optimization with the appropriate register type for the target device unless overridden by the user.

The modular, hierarchical structure of VHDL makes a team design approach feasible, while the ability to build libraries of pretested, reusable components and functions increases design productivity and control. And the fact that VHDL is an accepted standard means that designs are portable and can be reused as future subsystem designs, regardless of the design environment.

The arrival of VHDL also brings a new level of power by increasing the level of abstraction and complexity manageable in PLD designs. This development places a much greater demand on the synthesis capabilities of PLD compilers. That is, the most efficient logic solution for a given application is now as strongly affected by the quality of the synthesis tool as by the inherent architectural and technology advantages of the PLD component. Innovative architectures with high theoretical capacity are of little use if the synthesis tool lacks the intelligence to use it efficiently.

The preconfigured nature of some aspects of PLD architecture, and the inclusion of features designed to implement certain functions efficiently, require architecture-specific synthesis techniques. If the compiler doesn't have architecture-specific synthesis, the user most likely will have to adopt a structural design approach to invoke these PLD features most effectively.

Device-specific synthesis may not be available in many after-market, broad-line PLD tools that use only back-end fitters for post-synthesis area mapping. Similarly, PLD tools derived from gate-array synthesis tools may not incorporate PLD-device-specific synthesis, because such a capability may not be needed in logic synthesis for more generic ASIC architectures. By being aware of such issues, you can better evaluate the VHDL compiler features required for efficient behavioral VHDL design and synthesis for programmable logic. ☐

Al Graf, manager of programmable logic applications and product planning for Cypress Semiconductor, holds a BSEE from the University of California at Berkeley and an MBA from Santa Clara University, Santa Clara, Calif.

HOW VALUABLE?	CIRCLE
HIGHLY	534
MODERATELY	535
SLIGHTLY	536

You Need Tree City USA

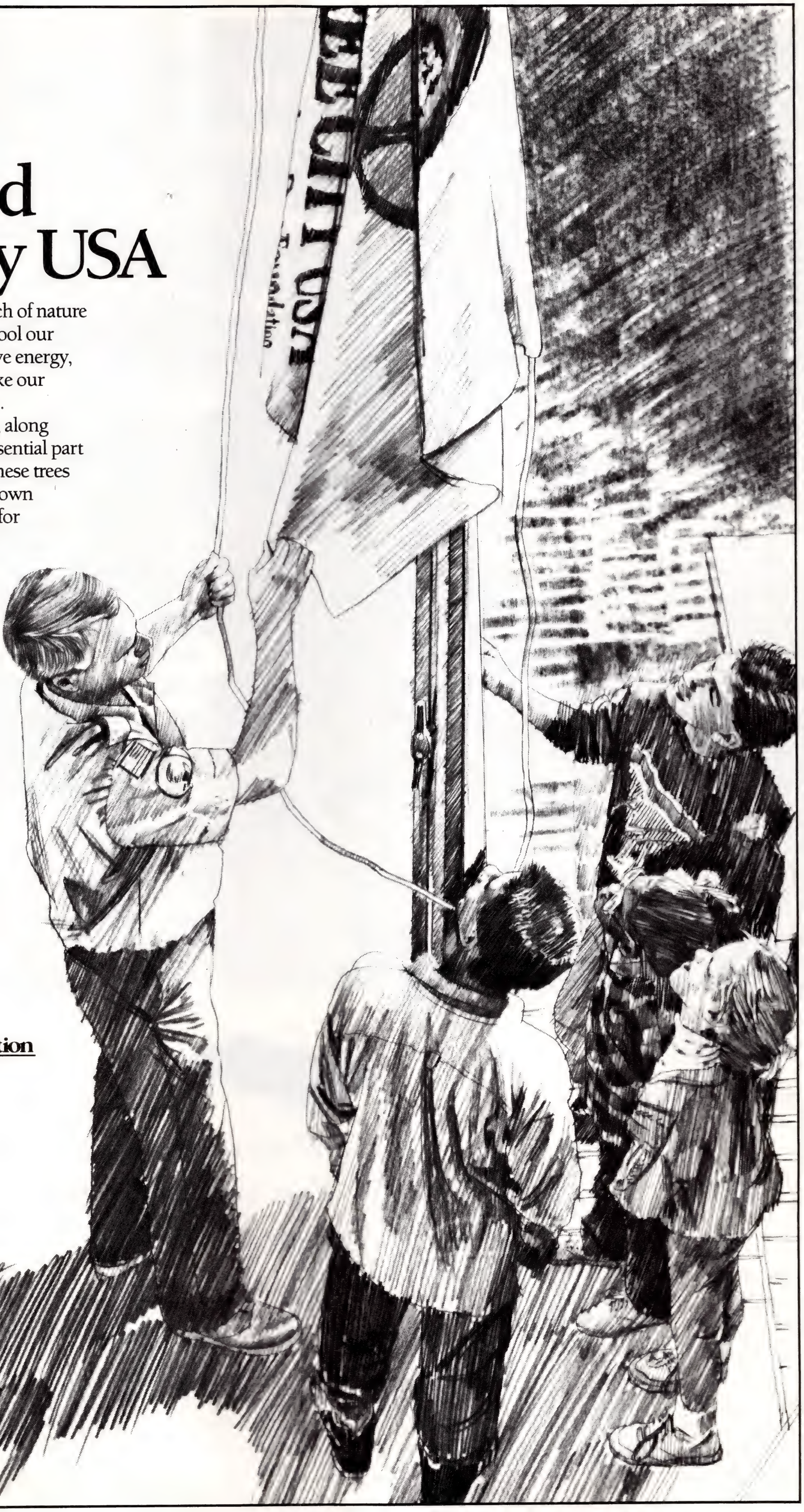
City trees add the soft touch of nature to our busy lives. They cool our cities, fight pollution, conserve energy, give wildlife a home, and make our neighborhoods more liveable.

The trees on city property, along streets and in parks, are an essential part of the urban forest. To keep these trees healthy and abundant, your town needs an organized program for their care…an annual action plan to plant and prune the city's trees, and to maintain their health.

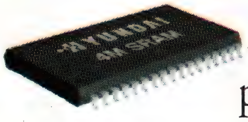
You can make a difference — by planting and caring for trees in your yard and in your neighborhood, and by encouraging your city government's community forestry program.

Support Tree City USA where you live. For your free booklet, write: Tree City USA, The National Arbor Day Foundation, Nebraska City, NE 68410.

The National Arbor Day Foundation



ISO 9001 Certified/Certificate NO,.927978



At Hyundai, we believe in providing our customers from all over the world with maximum satisfaction. We've always been there when you needed us and we plan to be there in the future. Whether you need reliable 64K or state-of-the-art 4M SRAMs, come to Hyundai Electronics, your global partner.

Hyundai Electronics Industries Co.,Ltd. HEAD OFFICE **KOREA** 10F Hyundai Jeonja Bldg., 66 Jeokseon-dong,Chonro-ku, Seoul, Korea Tel:02-398-4560/6 Fax:02-733-21

At Hyundai Electronics, we don't just think of you as a business counterpart, we think of you as a partner.. this is why we continuously strive to provide international clients with the widest selections and the highest quality to ensure maximum satisfaction. No matter what your memory needs, we've got the solution. Our SRAMs range from 64K to high performance 4M, while the high density leading-edge 4M SRAM will soon be added to our line up. To make things all the more convenient for you, DIP, SOP and TSOP packages are all available in a variety of speeds and voltages and industrial temperature range(-40 ℃to 85℃). Just think, you can now fulfill all your application, package and density needs from one highly reliable and renowned global partner. Hyundai Electronics, small innovations with big results.

PRODUCT	PART NO.	ORGANIZATION	SPEED	FEATURES	PKG. TYPE	AVAILABILITY
64K SRAM	HY6264A HY6264AL HY6264ALL	8K x 8	70/85/100/120	NORMAL L-PART LL-PART	PDIP, SOP	NOW
	HY6264AL-/ALL-I	8Kx8	70/85/100/120	NORMAL	PDIP, SOP	
256K SRAM	HY62256A HY62256AL HY62256ALL	32Kx8	55/70/85/100	NORMAL L-PART LL-PART	PDIP, SOP, TSOP-Ⅰ	NOW
	HY62256A/AL-I	32Kx8	55/70/85/100	NORMAL, L-PART (-40℃to 85℃)	PDIP, SOP	NOW
	HY62V256	32Kx8	85/100/120/150	3.0V to 5.5V	PDIP, SOP, TSOP-Ⅰ	NOW
	HY62V256 BL	32Kx8	100/120/150/200	2.7V to 5.5V	PDIP, SOP, TSOP-Ⅰ	'95.1Q
256K FAST SRAM	HY638256 HY638256L	32Kx8	15/17/20/25	NORMAL L-PART	PDIP, SOJ	'95.1Q
1M SRAM	HY628100A	128Kx8	55/70/85/100	NORMAL L-PART LL-PART	PDIP, SOP, TSOP-Ⅰ	NOW
	HY628100AL/ALL-I	128Kx8	55/70/85/100	L,LL-PART (-40℃to 85℃)	PDIP, SOP, TSOP-Ⅰ	'94.4Q
	HY62V8100AL	128Kx8	100/120/150/200	2.7V to 5.5V	PDIP, SOP, TSOP-Ⅰ	NOW
1M FAST SRAM	HY638100 HY638100L	128Kx8	15/17/20/25	NORMAL L-PART	SOJ	'95.1Q
4M SRAM	HY628400 HY628400L HY628400LL	512Kx8	55/70/85/100	NORMAL L-PART	PDIP, SOP, TSOP-Ⅱ	'95.1Q
	HY628400L/LL-I	512Kx8	55/70/85/100	L,LL-PART (-40℃to 85℃)	PDIP, SOP, TSOP-Ⅱ	'95.1Q
	HY62V8400L	512Kx8	100/120/150/200	2.7V to 5.5V	PDIP, SOP, TSOP-Ⅱ	'95.1Q

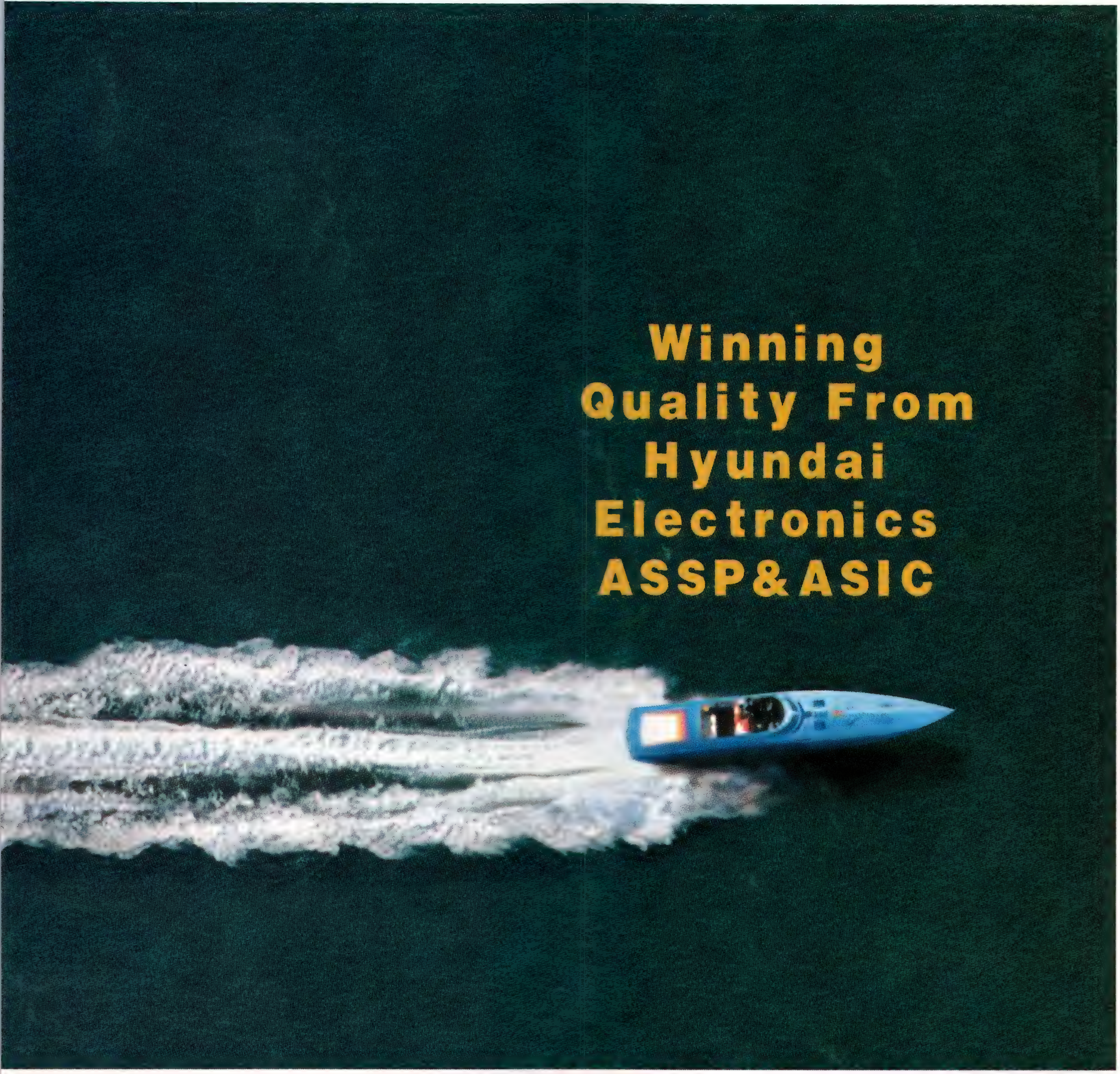
Committed to your success

HYUNDAI

Tel:03-3211-4701/8 FAX:03-3211-5447/8 **SINGAPORE** Tel:270-6300/7 Fax:270-6102 **TAIWAN** Tel:02-568-1134/5 Fax:02-543-3433 **HONG KONG** Tel:586-1470 Fax:842-1591/4

READER SERVICE 93

Hyundai Electronics, with vast resources and accumulated know-how, has expanded its business scope to include some of the most sophisticated micro products in the industry such as the MPEG-2, PC Chipsets, graphics, interface, DSPs, MCUs, etc. Supported by advanced designs, manufacturing technology and state-of-the-art quality control systems, the Hyundai Electronics System IC Division is focused on the development of ASSP for computers, Multimedia, Telecom Applications and ASIC products. To secure and develop some of the most powerful new technology, Hyundai Electronics has established R&D centers in San Jose and Boston of the United States, Taiwan, and Seoul, Korea with state-of-the-art MQFP quality test facilities with capacities of 1 million units per annum. The ambitious line of micro memory products, makes Hyundai Electronics one of the biggest and most comprehensive suppliers of semiconductors in the world. Now you can source virtually every memory and non-memory need with one internationally renowned partner. Hyundai, small innovations with big results.



Committed to your success

HYUNDAI

ISO 9001 Certified/Certificate NO,.927978

Hyundai Electronics Industries Co.,Ltd.

Head Office & Factory San 136-1, Ami-Ri, Bubal-Eub, Ichon-Kun, Kyoungki-Do, Korea 467-830 Tel: 02-741-0061, 0336-30-4114, Fax: 02-741-0737
SEOUL OFFICE Hyundai Jeonja Bldg., 66 Jeokseon-Dong, Chongro-Ku, Korea 110-052Tel: 02-398-4500/4620, Fax: 02-733-2145/7

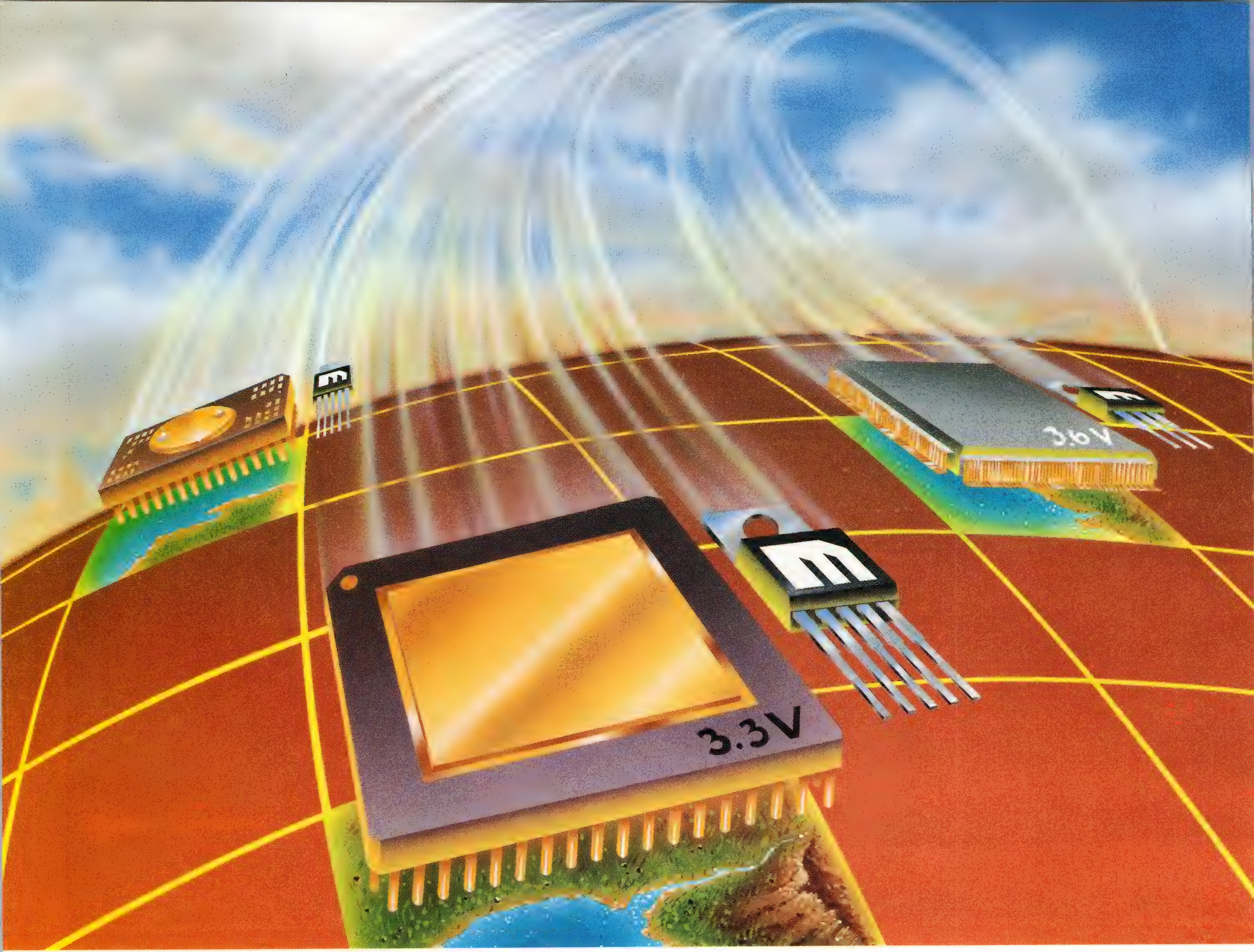
HYUNDAI ELECTRONICS AMERICA
SAN JOSE Tel: 408-473-9200/5 Fax: 408-473-9390
NEW JERSEY Tel: 201-262-7770 Fax: 201-261-2967
CANADA Tel: 416-882-5255/6 Fax: 416-882-5257
ATLANTA Tel: 404-242-6464 Fax:404-242-6554
L.A. CAR-AUDIO A/S CENTER Tel: 714 - 892 - 4599
Fax: 714 - 892 - 2843

HYUNDAI ELECTRONICS EUROPE
FRANKFURT Tel: 06-142 - 921-0 Fax: 06-142 - 921 - 2901/4
LONDON Tel: 081 - 741 - 1531 Fax: 081 - 563 - 0179

HYUNDAI ELECTRONICS ASIA
SINGAPORE Tel: 270 - 6300 Fax: 270 - 6102/6105

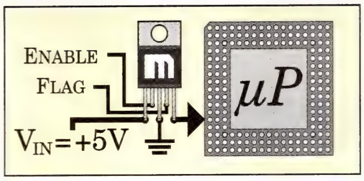
BRANCH OFFICE
TOKYO Tel: 81 - 3 - 3211 - 4701/8 Fax: 81 - 3 - 3211 - 5447/8
HONG KONG Tel: 586 - 1281 Fax: 596 - 081581
TAIPEI Tel: 886 - 2 - 568 - 1134 Fax: 886 - 2 - 543 - 3433

READER SERVICE 200



Micrel Brings Microprocessors Into the 3V World.

Today's processors need 5V. Tomorrow's will need 3.6V, 3.3V or 3.x V.



Regardless, Micrel has the LDO regulator for your application.

In the everchanging microprocessors world, one thing remains constant...Micrel. Our high current LDOs feature 300mV dropout voltage!

We have the enabling technology that lets you concentrate on the microprocessor, not the power supply. Our proprietary Superßeta PNP™ process allows the headroom for our 1.5 amp MIC29150 and 3.0 amp MIC29300 regulators to provide clean, stable voltage even from a 5V -10% (4.5V) input to a ≥ 3.6V output. Fixed or adjustable voltages. Full protection from over-current faults. Zero current shutdown mode. Out of regulation error flags and minimal ground currents.

What's this mean? Peace of mind...regardless of whether the microprocessor world goes to 4.2V or 2.2V. Contact Micrel Semiconductor, 1849 Fortune Drive, San Jose, California 95131. Phone **(408) 944-0800**. Fax **(408) 944-0970**.

MICREL
SEMICONDUCTOR
High Performance Analog Power ICs

READER SERVICE 229

CIRCLE 520

VERY EFFICIENT SOLENOID DRIVER

GEORGE ALTEMOSE
Pall Instrumentation Technology, 95 Oser Ave., Hauppauge, NY 11788-3799;
(516) 273-0911; fax (516) 951-2661.

Driving a number of high-power solenoids in a microprocessor-based system requires that power be conserved in the drivers, the power supply, and the solenoids themselves. This power conservation can be accomplished using a simple pulse-width-modulation approach to the circuit design.

In the circuit shown, the IC in the center, U1, contains a microprocessor-compatible serial-in, parallel-out shift register, with strobed latch and high-level solenoid drivers *(see the figure)*.

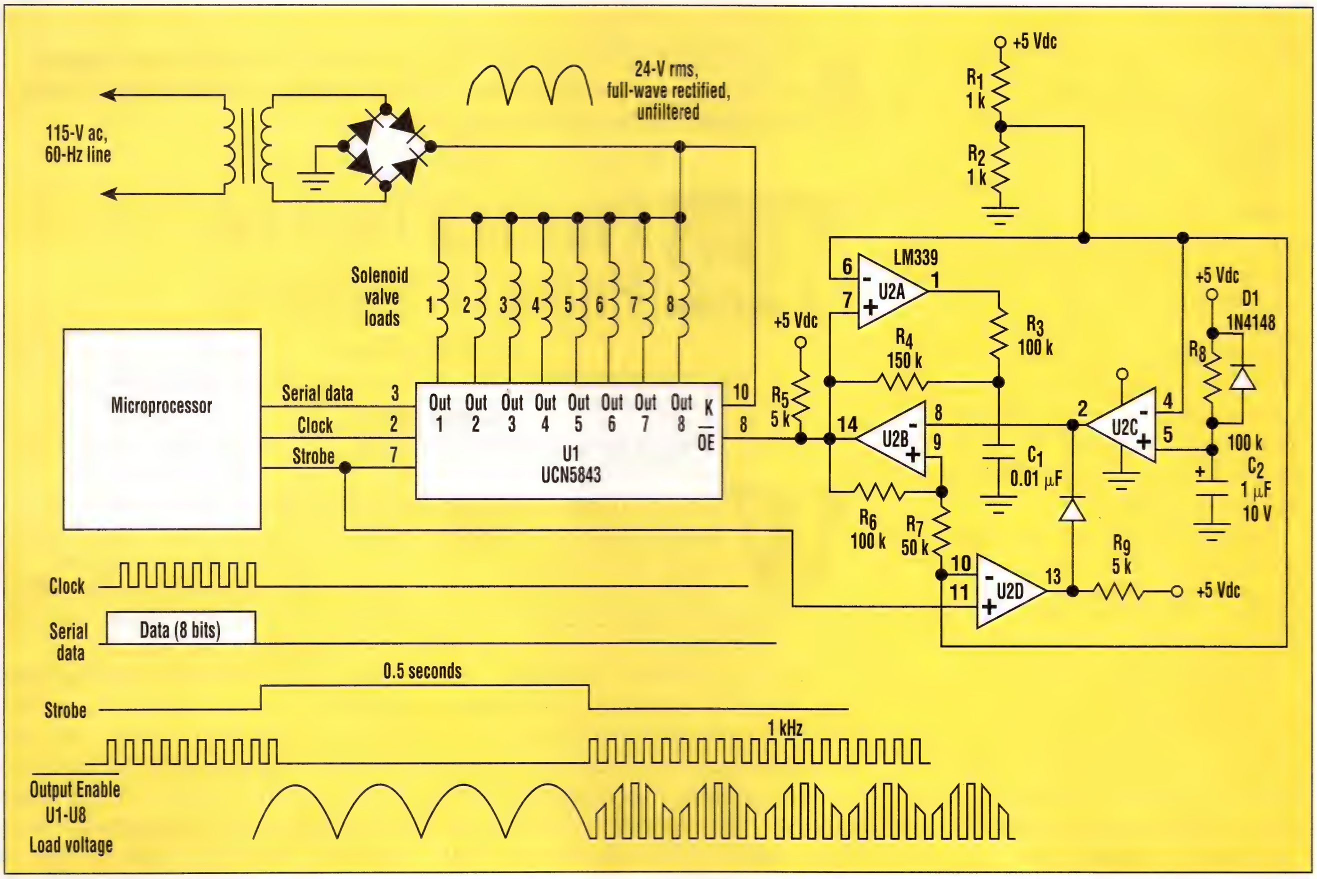
The strobe pulse turns on the selected loads at full power for its pulse width, which is 0.5 seconds. Following the strobe pulse, the driver outputs are pulse-width modulated by the multivibrator, which is set for a duty cycle of 25%. The solenoids are therefore held in the engaged position with a voltage that's 25% of the nominal supply voltage.

U2B acts as the basic multivibrator in the circuit, while U2A sets the duty cycle by setting the discharge current of capacitor C_1. U2D overrides the oscillation during the strobe pulse. And U2C provides the Power On Reset (POR), inhibiting the solenoid loads from turning on during the initialization period of the microprocessor.

The concept of voltage foldback after turn-on is valid for inductive devices, such as solenoid valves, relays, and contactors, which utilize moving armatures to complete a magnetic circuit. Prior to actuation, the air gap in the magnetic path requires that a relatively high pull-in voltage be applied to move the armature to the closed position. However, once the armature is in the closed condition, the flux density increases significantly, and thus a much lower voltage is required to keep the device energized.

The solenoid inductance also increases in the closed condition, and is sufficient to keep the current relatively constant during the pulse-width modulation. Note that U1 contains internal transient-suppression diodes.

Additional power can be saved by powering the solenoids with an unregulated, unfiltered full-wave rectified power supply with very low internal losses. Therefore, the actual power dissipation is much less than the full rated power consumption of the loads.☐



A SIMPLE PULSE-WIDTH-MODULATION approach can help conserve power in high-power solenoid drivers for microprocessor-based systems.

CIRCLE 521

DETECT FREQUENCY WITH LM556 TIMER

GARY KABITZKE
Allen-Bradley Co., 6400 W. Enterprise Dr., Mequon, WI 53902.

Today, many different frequency-detection schemes are available to circuit designers. The circuit described here can be another option for those who don't list accuracy as their major concern. It can be easily adapted to many other designs, but was originally developed to output a logic "1" if the engine speed in an automobile was above a specified rpm. In that design, a simple current transformer made up of a ferrite toroid and a couple of turns of wire transmitted pulses from one of the spark-plug wires into R_1 at the circuit input.

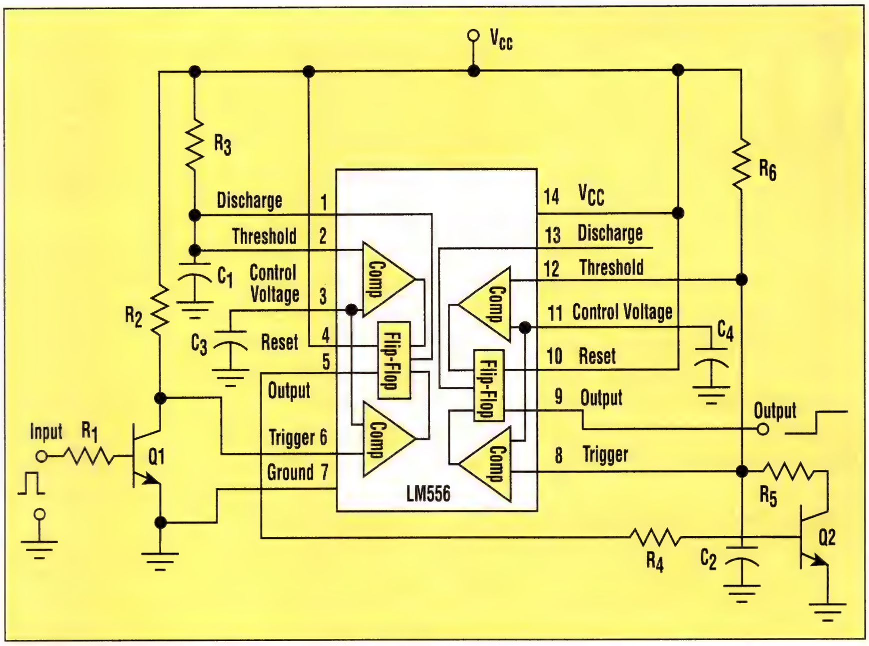
The circuit, *(see the figure)*, is built around an LM556 dual-timer IC. The 556's first timer is wired as a one-shot and is used to stretch the incoming pulses into fixed-length pulses. The second timer, which is similar to an astable multivibrator (pin 13 remains disconnected), functions as follows:

The one-shot's fixed-length pulses, which are output on pin 5, turn on Q2 and discharge C_2 through R_5. If the frequency of the pulses is high enough, the voltage on C_2 will fall below 1/3 V_{cc} and the second timer's output, pin 9, will go to a logic "1." Conversely, if the frequency is low enough or zero, the voltage on C_2 will charge through R_6 to a level above 2/3 V_{cc}, and the pin-9 output will go to a logic "0."

The idea is to keep the upper and lower peak voltage on C_2 below 2/3 V_{cc} and 1/3 V_{cc}, respectively, for a logic "1," and above 2/3 V_{cc} and 1/3 V_{cc}, respectively, for a logic "0."

To find the one-shot values, R_3 and C_1, select a pulse width ($1.1 \times R_3 \times C_1$) that's greater than the largest input pulse width and less than twice the inverse of the highest input frequency. To find R_5, R_6, and C_2, first determine the duty cycle (t_{on}/t_{off}) of the input signal. Next, choose a standard value for C_2 and calculate R_6:
$R_6 = [(t_{off} \times 0.61) + t_{off}]/C_2$

Also, $R_5 = R_6(t_{on}/t_{off})$. A tweak of resistors R_5 and R_6 may be needed to get the preferred response. Input signals with low duty cycles work the best. Finally, note that capacitors C_3 and C_4 can be any value between 0.01 and 0.1 μF.☐



THIS FREQUENCY DETECTOR, which uses the LM556 timer, was originally created for automobile engines to sense if a specified rpm was exceeded. However, it can be easily adapted to serve many other applications.

CIRCLE 522

PROTECT DRIVER FROM OVERLOAD

GLENN DE MICHELE
Harris Semiconductor Corp., Schaumburg, IL; (708) 240-3499.

and BOB URMAN
Vapor Division of Mark IV, Niles, IL; (708) 967-8300

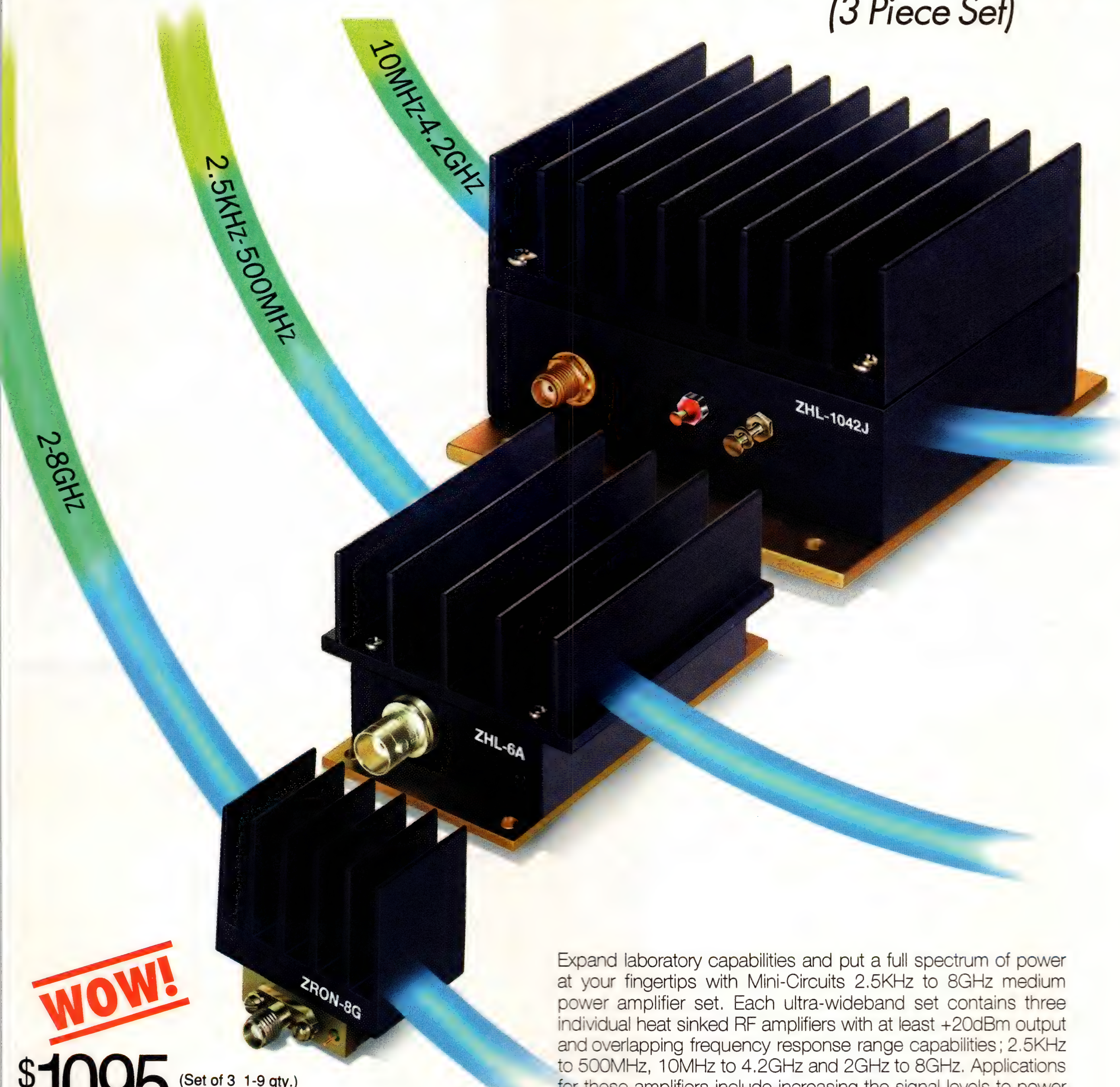
When driving medium-power external loads such as lamps, solenoids, or relay coils, it often is desirable to protect the driver with some type of overcurrent or overload protection. Personnel accustomed to installing electromechanical systems have been known to short loads momentarily and then watch for the spark, confirming proper driver operation. This procedure could render an unprotected driver inoperative.

There are several integrated solutions available, but cost and output current requirements may force designers to explore discrete solutions. Harris Semiconductor recently released three current-limited MOSFETs, one of which is shown in a low-side driver *(Fig. 1a)*.

The device turns on when the gate is pulled 5 V above the source. At low drain currents, Q1 stays off and MOSFET Q2 conducts the load current through internal current-sense resistor R_2. As I_d increases, the drop across R_2 becomes large enough to turn on Q1, which along with R_1 drops Q2's gate voltage. This way, the device goes into current limiting,

2.5KHz-8GHz AMPLIFIERS

(3 Piece Set)



WOW!

only $1095 (Set of 3 1-9 qty.)

+20dBm Power Output, 20dB Gain

Model :	Freq. (MHz)	Gain (dB)	Power Output, dBm @ 1dB Compression	DC Power		Conn. Type	Indiv. Price ($) (1-9 qty.)
				Volt V	Current mA		
ZHL-6A	.0025-500	21	+23	+24	350	BNC	199
ZHL-1042J	10-4200	25	+20	+15	330	SMA	495
ZRON-8G	2000-8000	20	+20	+15	310	SMA	495

Set of 3 Amplifiers # KZHL-318: $1095 (1-9 qty.)

Expand laboratory capabilities and put a full spectrum of power at your fingertips with Mini-Circuits 2.5KHz to 8GHz medium power amplifier set. Each ultra-wideband set contains three individual heat sinked RF amplifiers with at least +20dBm output and overlapping frequency response range capabilities; 2.5KHz to 500MHz, 10MHz to 4.2GHz and 2GHz to 8GHz. Applications for these amplifiers include increasing the signal levels to power meters, spectrum analyzers, frequency counters and network analyzers as well as boosting signal generator outputs.

You can buy these amplifiers individually at Mini-Circuits already low prices, or own the full spectrum set for the money saving price of only $1095 (1-9 qty.) ! To order from stock with a guarantee to ship within one week, call Mini-Circuits today !

Mini-Circuits...we're redefining what VALUE is all about!

Mini-Circuits®

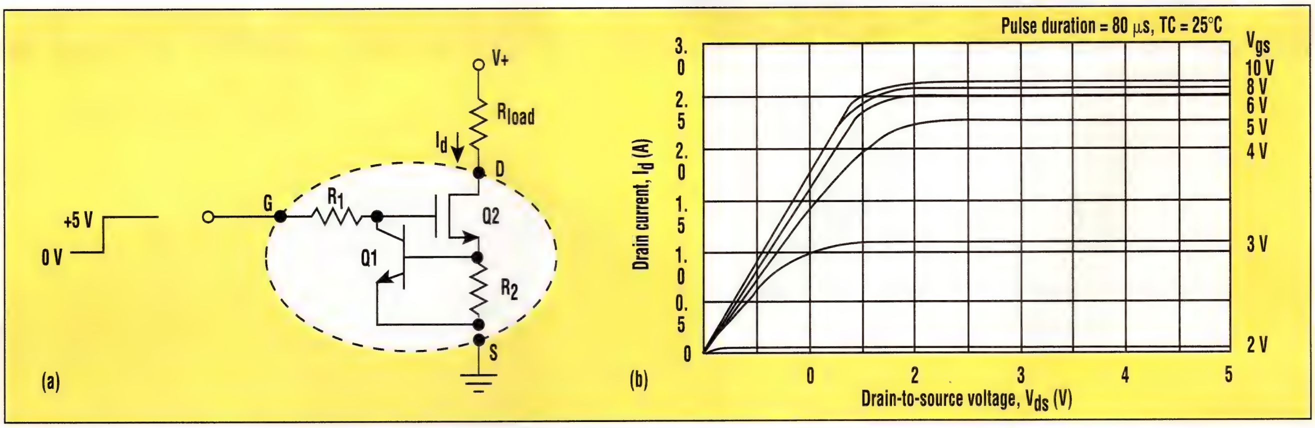
P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

r detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

F 176 Rev C

READER SERVICE 116



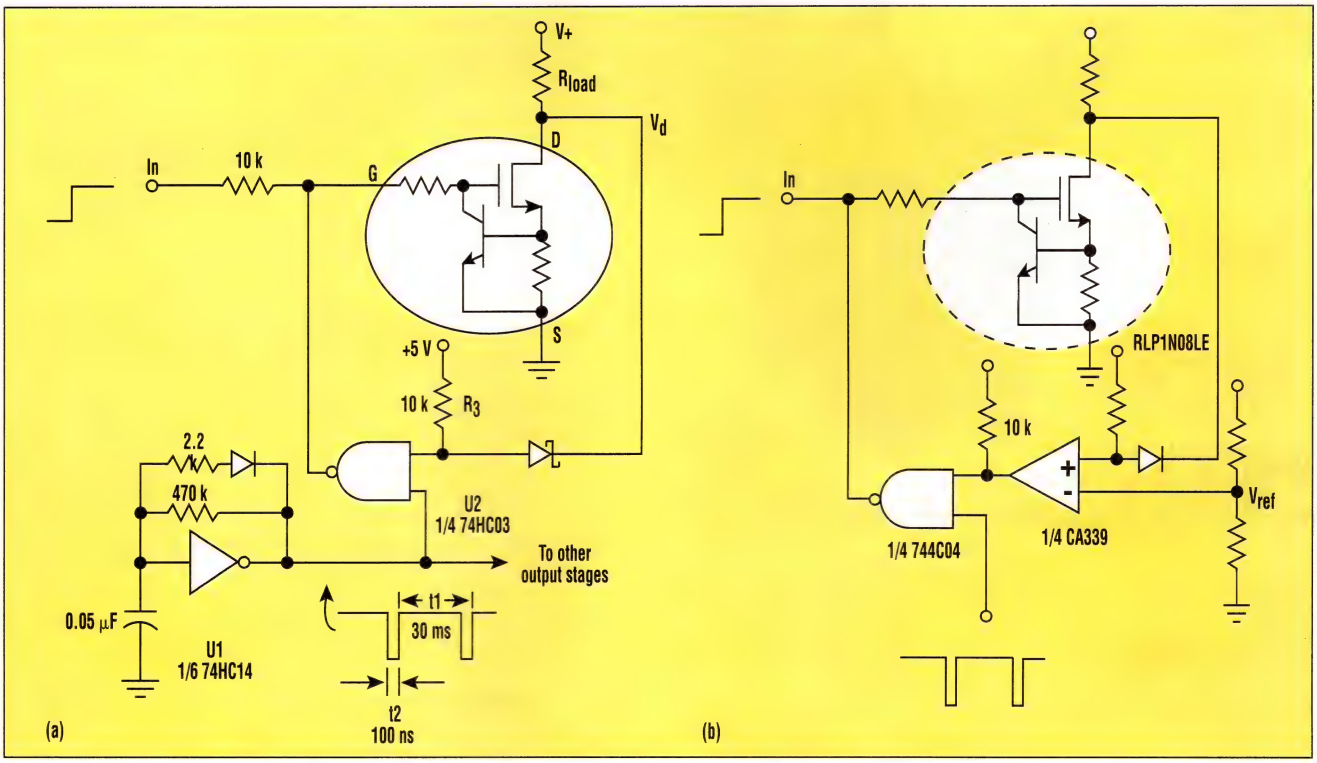
1. A CURRENT-LIMITED MOSFET is employed in this low-side driver to help protect it in the event of a load fault, or when momentary load shorts occur during system installation (a). The MOSFET's on-state V-I curve shows that the device has a fairly low on-state drop until I_d hits the limit threshold (b). Then, V_{ds} breaks away from the low forward drop as the device becomes a nearly constant current sink.

maintaining a V_{be} across R_2. This low-side driver circuit will indeed limit the short circuit current, but depending upon the value of the V+ supply voltage, enough power may be dissipated in the device to provoke a thermally-induced failure. Datasheet curves for the current-limiting MOSFETs prescribe safe operating areas as a function of on-state V_{ds}, temperature, time, and heat-sink thermal resistance.

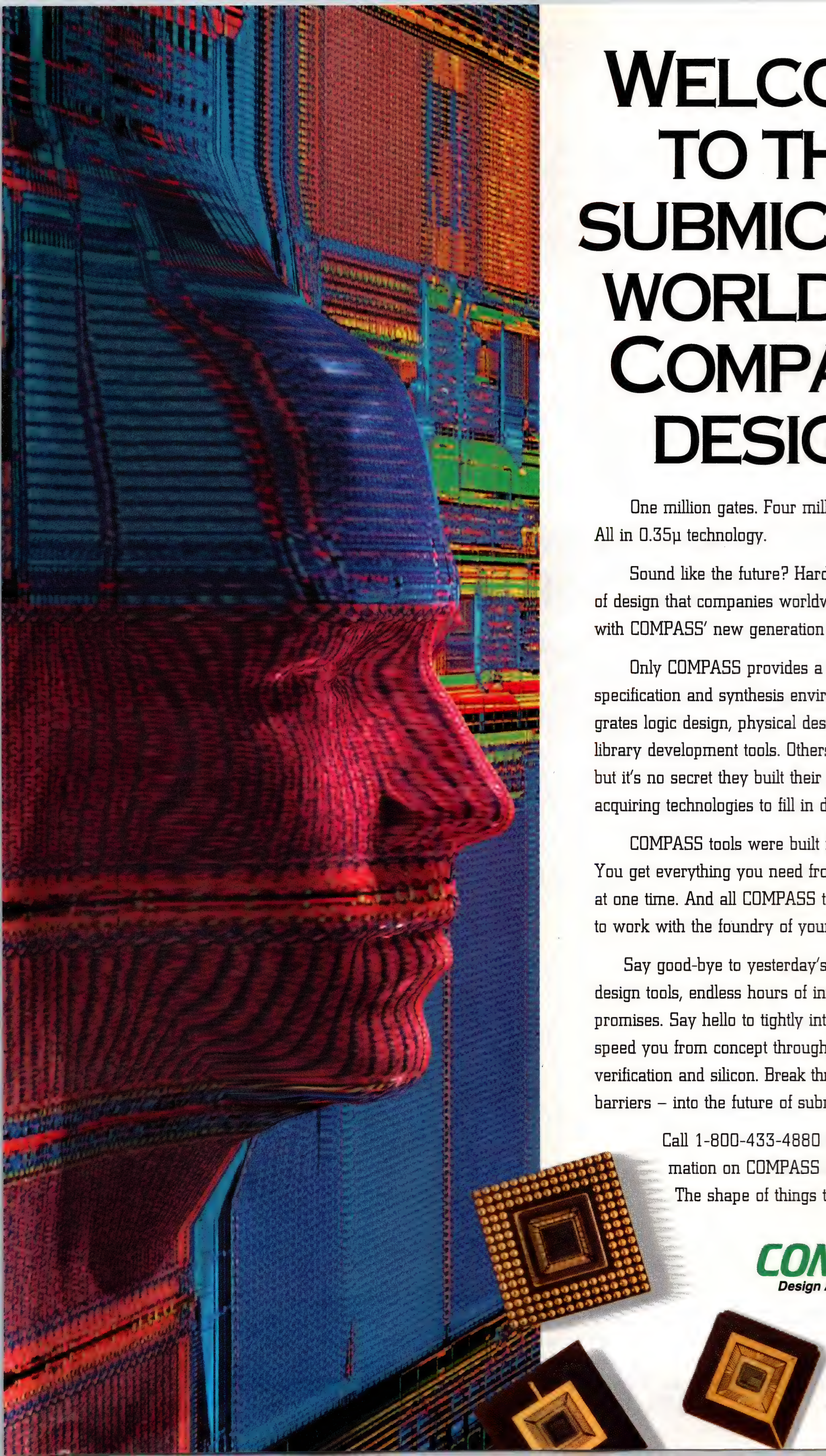
The on-state V-I curve of the RLP1N08LE 1-A device shows that the MOSFET has a fairly low on-state drop until I_d hits the limit threshold *(Fig. 1b)*. At this point, the V_{ds} "breaks away" from the low forward drop as the device becomes a nearly constant current sink. By sensing this increase in V_{ds}, the drive can be removed easily from the MOSFET using external circuitry. Shutting off the drain current before the die temperature rises appreciably enables full overload protection to be provided *(Fig. 2a)*.

A Schmitt-trigger inverter oscillator, U1, provides a train of gating pulses. Under normal load conditions, the "In" pin is high, and V_d is near ground. The output of U2, an open drain NAND gate, stays high, allowing the gate-drive signal to stay high. If the load becomes shorted, the MOSFET current limits and V_d goes to V+, which allows R_3 to pull up the input of U2.

If the short occurred during time



2. THE CURRENT-LIMITING THRESHOLDS in this circuit are set by the MOSFET, and the shutdown threshold is set by V_{il} of the 74HC03 (a). It does, however, have a sloppy unit-to-unit trip point (0.86 A to 2.6 A), due primarily to unit-to-unit variation of V_{il} of the 74HC03. To more tightly control the trip point, a CA339 voltage comparator can be added (b).



WELCOME TO THE SUBMICRON WORLD OF COMPASS DESIGN

One million gates. Four million transistors. All in 0.35µ technology.

Sound like the future? Hardly. That's the kind of design that companies worldwide are achieving with COMPASS' new generation of IC design tools.

Only COMPASS provides a seamless graphical specification and synthesis environment that integrates logic design, physical design, libraries and library development tools. Others make this claim but it's no secret they built their product line by acquiring technologies to fill in design "holes."

COMPASS tools were built from the top down. You get everything you need from one company, at one time. And all COMPASS tools are designed to work with the foundry of your choice.

Say good-bye to yesterday's mix-and-match design tools, endless hours of integration and empty promises. Say hello to tightly integrated tools that speed you from concept through synthesis, layout, verification and silicon. Break through today's design barriers – into the future of submicron design.

Call 1-800-433-4880 for more information on COMPASS design tools. The shape of things to come.

COMPASS
Design Automation

READER SERVICE 281

Synthesis to Silicon

COMPASS Design Automation,
1865 Lundy Avenue, San Jose, CA 95131
© 1994 COMPASS Design Automation, Inc.
The COMPASS logo is a registered trademark
of COMPASS Design Automation, Inc.

t1, U2 will pull the gate to ground, immediately removing drive to the FET. During time t2, when the pulse oscillator is in its low state, the V_d signal is ignored, and gate drive will be applied as long as In is high. Time t2 is selected to be short enough to limit the die temperature rise of the FET during a shorted load condition. Time t1 is selected to be long enough to limit the accumulation of this heat. Using this method, the shorted load is "polled" during time t2, and U2 allows continuous gate drive to be reapplied as soon as the MOSFET comes out of current limiting and V_d goes low.

In Fig. 2a, the current-limiting thresholds are set by the MOSFET, and the shutdown threshold is set by V_{il} of the 74HC03. Using the maximum value of R_{ds}on of the MOSFET and the maximum V_{il} of the 74HC03, the circuit is guaranteed to deliver at least 860 mA before shutdown will occur.

At the other end of the scale, the 74HC03 may not sense that its input has gone high until that voltage reaches its V_{ih} minimum of 3.5 V.

In this situation, the MOSFET is well into current limiting, and will have about 3.3 V from drain to source, which may correspond to 2.6 A of drain current *(Fig. 1b, again)*. To ensure the MOSFET's survival, a heat sink should be provided to allow for power dissipation when the device isn't shut down. The sloppy unit-to-unit trip point (0.86 A to 2.6 A) of this circuit is due mainly to the possible unit-to-unit variation in the V_{il} voltage of the 74HC03.

The trip point can be more tightly controlled by employing a CA339 voltage comparator *(Fig. 2b)*. When using this circuit, the shutdown will occur at a precise drain-to-source voltage, and the worst-case power dissipation is more easily predicted and constrained.☐

CIRCLE 523

SPARE CHANNEL NETS 12-V SUPPLY

STUART SMITH
Elantec Inc., 1996 Tarob Court, Milpitas, CA 95035.

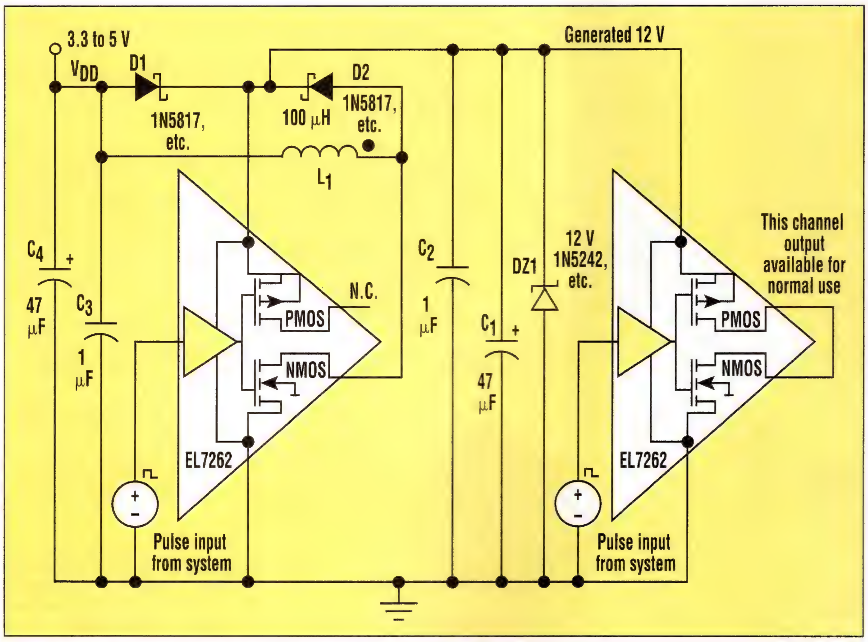
When driving a power MOSFET from a 5-V or 3.3-V system, a significant number of components usually are needed to generate an extra +12-V power supply.

It's possible, however, to apply the second channel in a typical dual MOSFET driver to derive a +12-V power supply. By using a driver with the drains brought to separated pins, designers can connect an inductor between the n-channel drain and the logic supply without connecting the p-channel device.

The driver operates as a standard flyback-style switched-mode circuit *(see the figure)*. When the output n-channel device is on, current starts flowing in the inductor, which stores energy. When the n-channel device is turned off, current must continue flowing. Therefore, it flows through diode D2 to charge up C_1 and C_2. As the cycle repeats, the C_1 and C_2 voltage rises until the Zener diode prevents further voltage rise. This is needed to prevent the drivers' derived supply from exceeding the part's maximum voltage rating.

To minimize external components and cost, self-oscillating and -regulating components are omitted. The logic system can supply a drive pulse waveform to the supply generator. With the 5-V system, a 1.5-µs pulse was used every 9 µs. This provided a solid 12.4 V, and system current rose by 11 mA. The 3.3-V system used a 300-kHz square wave for a similar 12-V derived supply, but with nearly 40 mA of extra supply current. When the MOSFET driver wasn't being used in either of the systems, it could be "powered down" by stopping the pulses to the switching channel.

Any dual MOSFET driver can be used, but if the output-stage drains aren't separated, there may be some protection and other parasitic devices that may prevent satisfactory operation. In these cases, an external FET can be used to drive the inductor, provided a low threshold device is utilized. By altering the inductor value and the controlling pulses, enough power can be derived for further MOSFET drivers or other peripheral devices requiring +12 V.☐



AN ADDITIONAL +12-V POWER SUPPLY can be derived in a dual MOSFET driver by applying the spare second MOSFET driver. If the driver's drains are brought to separated pins, it's possible to connect an inductor between the n-channel drain and the logic supply without connecting the p-channel device.

ELECTRONIC DESIGN

QUICK LOOK

EDITED BY SHERRIE VAN TYLE

MARKET FACTS

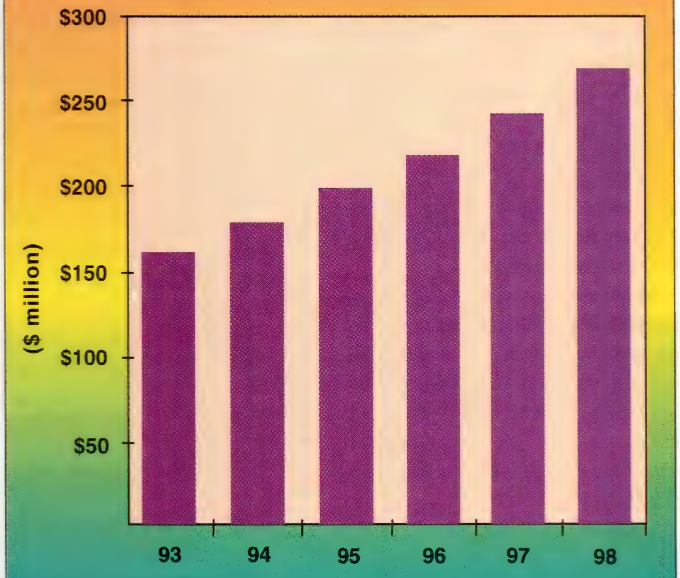
The desire for open systems is propelling growth of software for interfacing with programmable logic controllers (PLCs). That's according to a study by Venture Development Corp. titled "The Evolving U. S. Market for Personal Computers and Software for Programming and On-Line Operation with Programmable Logic Controllers."

At least 80% of the PLCs in use are programmed from PCs, which are rapidly displacing proprietary progamming devices. The Natick, Mass., company also found that 45% of PLCs currently interface with at least one PC during operation. By 1998, 68% of PLCs will interface with a PC.

This trend is accompanied by growth in software to supply this interfacing. U. S. sales of such software are predicted to increase from $162 million in 1993 to reach $268 million in 1998, despite erosion in prices. Sales of programmable logic controllers, on the other hand, are expected to grow more slowly, at a compound annual rate of just 6.4%.

Standards are being more important, with proprietary networks being replaced by standard networks, especially Ethernet. Efforts to standardize lie behind PLC Open, an industry group formed in Europe that has spread to the U. S. and supports the development and adoption of IEC 113-3 standards on programming languages for PLCs. It also defines standards for structured text and instruction text languages.

SOFTWARE FOR INTERFACING PCs TO PLCs WILL GROW STEADILY



Source: Venture Development Corp.

EYE ON ISO 9000

Optical Cable Corp., which supplies fiber optic cables for communications, has been awarded ISO 9001 certification. Contact Susan E. Smith, vice president of marketing, Optical Cable Corp., P. O. Box 11967, Roanoke, VA 24022-1967; (703) 265-0690; fax -0724. *BN* CIRCLE 461

NCR Microelectronic Products Div., a division of AT&T Global Information Solutions (formerly NCR Corp.) leading suppliers of SCSI chips, SCSI software and cell-based, mixed-signal ASICs, Ethernet controllers, graphics accelerators, and gate arrays has achieved ISO 9001. Contact NCR Microelectronic Products Div., 2001 Danfield Ct., Fort Collins, CO 80525; (800) 334-5454. *BN* CIRCLE 462

Tektronix Inc. Test & Measurement Div. has achieved ISO 9001 certification for its designs, manufacturing, and services for oscilloscopes, VXI, instrumentation, meters spectrum analyzers, logic analyzers, and test bench and service equipment. For further information, contact Tektronix Inc., Test & Measurement Div., P. O. Box 1520, Pittsfield, Mass. 01202-9864; (800) 426-2200. *BN* CIRCLE 463

Beckman Industrial Corp., an affiliate of Emerson Electric Co., has received ISO certification for three primary manufacturing facilities. Fullerton, Calif., corporate headquarters, has been certified for ISO 9001; Glenrothes, Scotland has received ISO 9001; and Mexicali, Mexico has received ISO 9002 for the manufacture of trimming potentiometers, precision potentiometers, thin-film resistor networks and hybrid microcircuits, thick-film resistors, and resistor/capacitor networks. For further information, contact Beckman Industrial Corp., 4200 Bonita Place, Fullerton, CA 92635; (714) 447-2371; fax -2400. *BN* CIRCLE 464

American Microsystems Inc. has been awarded ISO 9001 for its digital and mixed-signal ASIC products, including programmable logic devices, gate array and standard cell products, and application-specific standard products, as well as for contract manufacturing and foundry services and custom integration solutions such as multichip modules. For more information, write on company letterhead to American Microsystems Inc., 2300 Buckskin Road, Pocatello, Idaho 83201; (208) 233-4690. *BN* CIRCLE 465

QUICK REVIEWS

Systems based on high-performance microprocessors typically get their last 20% to 40% of their raw performance gains from the use of large secondary caches. As a result, the proper cache architecture and approach is critical for squeezing the last SPECmark in performance from the silicon. *The Cache Memory Book*, written by Jim Handy, a senior analyst for semiconductor memories at DataQuest Corp., San Jose, Calif., provides designers with an in-depth analysis of cache approaches and implementation discussions.

The five chapters in the 250-page book detail the basics of cache, the physical design issues such as unified vs split caches, line-size tradeoffs, write-through vs copy-back, and the use of cache with CISC and RISC microprocessors. The book gives details on cache coherency issues in both uniprocessor and multiprocessor systems and some system design examples using Intel 80x86 and Motorola 680x0-family processors.

The book covers RISC system cache design issues in Chapter 3 but gives no design examples, one shortcoming in an otherwise good overview of cache design. Copies of the $44.95 book (ISBN: 0-12-322-985-5) can be ordered from Academic Press Inc., 955 Massachusetts Ave., Cambridge, MA 02139; (617) 876-3901. *DB*

QUICK NEWS: CONFERENCES

The DAVID Developers Conference will be held in conjunction with the Convergence '94 Interactive Television Conference/Expo on Sept. 28—30 at the Santa Clara Convention Center. The developers conference will focus on real-world, end-to-end interactive television products and technologies that incorporate or target Microware's Digital Audio/Video Interactive Decoder. For more information, contact Microware Systems Corp., 1900 NW 114th St., Des Moines, Iowa 50325-7077; (800) 475-9000; (515) 224-1929; fax -1352; e-mail: info@microware.com. CIRCLE 466

The fifth national technology transfer conference and exposition, Technology 2004, will be held Nov. 8–10, 1994 in the Washington DC Convention Center. It is sponsored by NASA, the Technology Utilization Foundation, and the Federal Laboratory Consortium for Technology Transfer. Contact Technology Utilization Foundation, c/o Technology 2004, P. O. Box 614, Brookfield, IL 60513. CIRCLE 467

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
P. O. Box 1070, 100 Prickly Pear Rd., Verdi, NV 89439; (702) 345-1455; fax (702) 345-0804

TTM and BEAR make BET. In words, the sum of time to market, TTM, and break-even after release, BEAR, equal BET. This decomposition, while mathematically entertaining, also helps simplify some of the work associated with effective use of the BET metric in some new product development environments. For instance, a good friend of mine runs a company focused on serving the back-up mass storage market. Entry products include tape drives, while more sophisticated technologies form the backbone of higher performance product alternatives. Competitors, around five worldwide, actively struggle to advance customer contribution through reduced prices and better performing product offerings—all participants serving this market work very hard to stay afloat.

Other characteristics about this company worth knowing include: (1) they know how to market new products effectively; (2) their manufacturing arm routinely ramps to high volumes rapidly; (3) their sales force, given a reasonably good product, gets orders quickly; and (4) the company's distribution channels work in a near optimal fashion getting product from manufacturer to end user with minimal delay and cost. The listed items contribute significantly to the magnitude of the BEAR parameter. Any company acting responsibly with respect to these items positions itself for minimization of BEAR time. On the other hand, please note that none of these parameters affect time to market performance.

Now I ask the question, would installing measurement of the complete break-even time metric into this new product development environment make sense? I think not and here's why . . .

When you routinely perform the four highlighted items, you have break-even time after release in control. With a good product, and with the processes that contribute to the BEAR metric working reasonably well, little competitive advantage remains to be gained. You might be able to pick up some advantage, but expect gains to be small. Think of it this way—if the new product attracts customers and your organization delivers at close to the rate of market demand, what new information does measuring break-even after release provide? In this environment, measuring time to market stand-alone produces the desired results.

Now explore the other side though this example. Here we have a company emerging from its start-up seed with its first new product. Staffers think they can market, sell, manufacturer, and distribute, but as a collective team they have not done it before. The probability, of this new collection of people doing a collection of new things encountering serious problems, equals one. Rigorous comparison of actual profit generation to targeted profits provides early insight into operational problem areas. So here, measurement of BEAR makes a lot of sense.

So for some, measuring BEAR contributes to organization performance and for others the impact remains slight. For the two examples described, who do you think really measures BEAR?

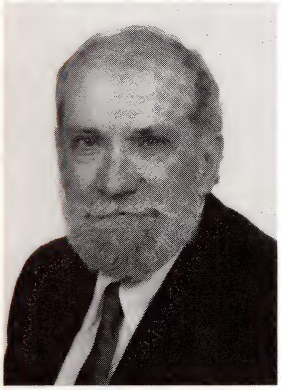
Yes, you are right—the company that has little need to do so does, and the one who could benefit the most does not! Experienced, high performing, organizations with little, or no need, to directly measure BEAR do so. It becomes second nature: the data get crunched; machines produce the graphs. And inexperienced organizations that could benefit immensely from the information don't have it.

Investigate your environment. Would having BEAR data help you identify potential problems? Or might you be struck on the treadmill just wasting energy?

Ron Kmetovicz's The One-Minute Time to Market Self Assessment, which identifies five key behavioral patterns exhibited by fast-moving new product development organizations, is available free to the readers of Electronic Design by contacting Time to Market at the address above.

...Cleveland, Cards, and Golf

BY FRANK J. BURGE
Director of Market Development for Electronic Design



When I had lunch with a friend who works for a Silicon Valley semiconductor company, I said that I had recently returned from a great market focus meeting on Catawba Island. "Where's that?" she asked. When I told her that Catawba is in Lake Erie, off the coast of Cleveland, I thought she would choke on her burrito.

I'd never heard of the place either. As beautiful as Cape Cod, Catawba Island is nestled in the arms of Lake Erie. On a delightful boat trip to the neighboring Put-in Bay, one could see the Canadian islands in the distance and the skipper pointed out that Middle Island is the southern most point in Canada (here's a great Trivial Pursuit question).

After I described the island, my friend wondered why people's perceptions are difficult to change. The perception that Cleveland is a dying town in the heart of the rust belt and that Lake Erie is polluted beyond repair is wrong on both counts.

The company my friend works for suffers from a similar perception problem. For the past several quarters, the semiconductor maker, with $2 billion-plus in revenues, has turned in record profits. Yet every time the San Jose paper writes the good news, they always note that the company isn't a player in the memory or microprocessor markets, inferring somehow that only companies making microprocessors or memory should rack up $2 billion in revenues. What's more, it's almost as if the reporters believe the record profits result from pure luck rather than a carefully orchestrated strategy that focuses on the less volatile, but high growth market segments in which the company has a sustainable competitive advantage. Old notions die slowly.

While we were on Catawba Island, our free time was devoted to golf and poker. Fortunately I sprained my ankle the day of the golf tournament so I spared myself the distinction of being the worst in class. And since I am asthmatic, I stay clear of smoke-filled poker palaces. But there is something about golf and poker. A friend once told me that you can judge the character of a man by the way he handles himself at the poker table and the way he plays golf.

Yet the thought of being judged on the basis of my golf game bothers me—though not because I am a bad golfer (I am in fact a terrible golfer). A few years ago, the chairman of the company I worked for asked me to be his partner in a company-sponsored tournament. I explained that I would probably ruin his day, but he persisted, and I agreed. Rumor had it that he wanted to get to know me and he had an idea that golf is the real measure of man's worth. Nutso isn't it? If it weren't for getting into trouble on 16 holes, I would have had a great score, but I came in with 123.

Not bad I thought. But the chairman was miffed. I figured he was out of sorts when he stopped talking to me after the 10th hole. But what really bothered him was that I won the "closest to the hole" contest when my drive hit a tree and ricocheted to within three feet of the pin. He never did invite me to his monthly poker game. About a year later, my job was eliminated in a downsizing blitz. Fore!

I wonder if the same golf-and-poker measure would apply to women today. That's not to say that some women don't enjoy golf and are good at it. And some women may enjoy a good cigar when they play cards with the boys. But the idea that golf and poker are measures of a person's worth in business is probably history. Maybe we can invent a new measure of worth: for openers, how about smarts, enthusiasm, and a passion for exceptional results?

Digital Signal Processing

DSP Development Tools and OEM DSP Systems from Ariel

For PC/ISA/EISA:

PC-Hydra—Modular, TIM-40 based DSP platform with four TMS320C40 DSPs. Fast static and high-density dynamic RAM TIM Modules can be mixed and matched to suit any multiprocessing configuration. Twelve 20 Mbyte/sec communication ports, DT-Connect and DSP Port serial I/O.

DSP-C40 Cyclops—Powerful TMS320C40 DSP with huge static and dynamic RAM capacity, *six* 20 Mbyte/sec communications ports, DT-Connect and 16-bit analog I/O. GlobalBus+ for shared memory multiprocessing. Vast development software and operating system support.

PC-TeraDon—Another Ariel first: up to sixteen floating point DSPs in a single PC slot. Based on four quad-DSP DON Modules and the AT&T DSP3210, PC-TeraDon can be built to suit for a wide range of DSP, telephony and multimedia applications. AT&T's VCOS and the PC-TeraDon's dual MVIP interfaces make this the best platform for multi-channel telephony systems.

For VMEbus:

V-C40 Hydra—Four TMS320C40 DSPs on a single 6U VME card yield up to 200 MFLOPS, and an incredible 1.1 *billion* operations per second. Each DSP has two parallel banks of zero wait-state RAM, and up to 64 Mbytes of DRAM is shared among all DSPs and the VMEbus. Unparalleled software support.

Hydra-II—Four TMS320C40 DSPs with up to *32 Mbytes* of static RAM on a single 6U VME card. 32 Kbytes true dual-port RAM shared among all DSPs and VMEbus. Ultra-high-speed I/O via dual processor busses. Most cost-effective C40 board for OEM/volume applications.

CommIO—The most flexible I/O available for C40-based DSP systems. CommIO has sites for up to four industry-standard IndustryPacks and a dedicated TMS320C40 to handle data packing and routing via communication ports to other TMS320C40s (such as Ariel's Hydra series boards). CommIO can also be programmed as a stand-alone system for less compute-intensive applications. The IndustryPack is an open standard with over 50 different I/O modules available from a number of suppliers handling ADC/DAC up to 10 MHz, multichannel audio-bandwith I/O, synchronous serial I/O, Ethernet, SCSI, and more.

For You:

We at Ariel are dedicated to providing you with the best in high performance DSP products. Our products are designed, built, and supported in the U.S., sold direct through North America and are available worldwide through our international dealer network.

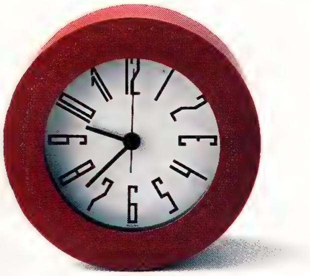
Call for our new catalog!

Ariel Corporation
433 River Road
Highland Park, NJ 08904
Tel: (908) 249-2900
Fax: (908) 249-2123
BBS: (908) 249-2124
email: ariel@ariel.com

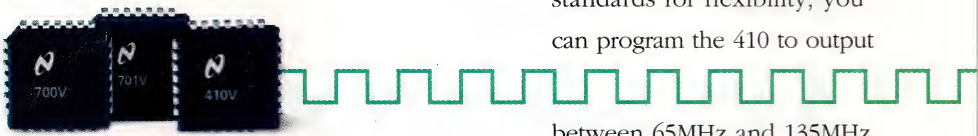
Ariel

READER SERVICE 162

© 1994 National Semiconductor. All rights reserved.



Accurate. Programmable.



Other clocking devices are behind the times.

Stay in sync with National Semiconductor's new timing solutions.

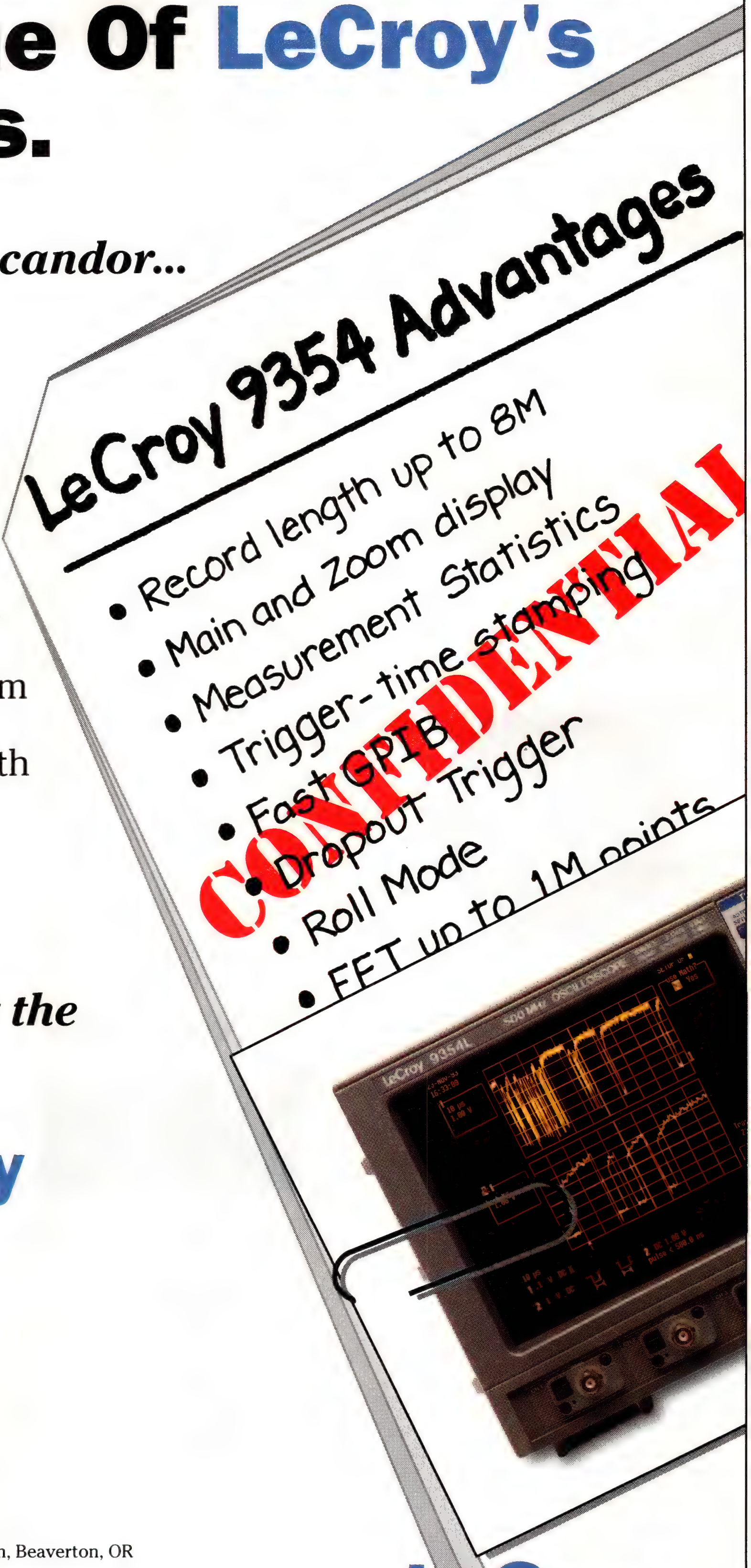
Today's high-end PCs and workstations demand the most accurate system timing available. With that in mind, National has developed a new portfolio of clock generators that deliver unmatched precision and performance. For example, our CGS700V integrates nine synchronous clocks in one device for the timing of a RISC or CISC processor and a host of peripheral functions. The CGS701V offers eight clocks and external feedback. And our CGS410V meets the unique needs of video/graphics subsystems. Based on PLL technology, these devices provide high speeds (up to 160MHz) as well as low jitter/skew (CGS700/701 of <300ps, CGS410 of <500ps) for the distribution of accurate signals. They also set new standards for flexibility; you can program the 410 to output between 65MHz and 135MHz from a fixed input of 35MHz, while the 700 and 701 take 25MHz to 40MHz and let you select and distribute signals at 1x, 2x, or 4x the input. Sound timely? Then call us at **1-800-NAT-SEMI, Ext. 315** for more information on our portfolio of timing solutions.

National
Semiconductor

A Recent Tektronix® Report Listed Some Of LeCroy's Advantages.

While we admire their candor... here are a few of the things they missed:

- The highest resolution display in the industry
- Up to 4 simultaneous Zooms
- Advanced Peak Detect system
- Sophisticated Waveform Math
- Internal Graphics Printer



LeCroy 9354 Advantages

- Record length up to 8M
- Main and Zoom display
- Measurement Statistics
- Trigger-time stamping
- Fast GPIB
- Dropout Trigger
- Roll Mode
- FFT up to 1M points

CONFIDENTIAL

If you would like to get the whole story, call:

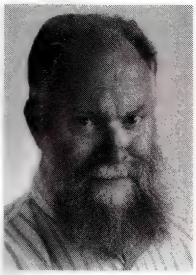
1-800-4LeCroy
(1-800-453-2769)

LeCroy Corporation
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977

Tektronix is a registered trademark of Tektronix Corporation, Beaverton, OR

LeCroy
Innovators in Instrumentation

PEASE PORRIDGE



BOB'S MAILBOX

Dear Mr. Pease:

An ex-student of mine, Anthony Bentley, sent me a copy of your June 13 article on Fuzzy Logic. Tony was in charge of Feedback Control in the Welding Department at Sandia in Livermore and transferred a few months ago to Feedback Control Applications at Sandia in Albuquerque. He successfully designed automated machines for a variety of welding systems. He feels pretty much the same as you about Fuzzy Logic, and so do I.

You might be amazed at the large number of highly mathematical journals devoted entirely to Fuzzy Logic—mathematics for its own sake. My own research area is in feedback design for highly uncertain systems—linear, nonlinear, time-invariant or time-varying, single and multiple input-output—with emphasis on quantitative design. I have tried to judge F.L. by seeking a significantly uncertain system, showing a systematic F.L. design procedure for trying to achieve desired performance specifications.

For example, consider a 4-by-4 multiple-input multiple-output, highly uncertain, nonlinear, time-varying system with assigned performance tolerances. We have a systematic design procedure that can handle problems such as this. In fact, this particular one can be done in a few hours without even using a computer. Anyhow, after a few hours in the library (besides always being on the lookout for such), I was not able to find a single such F.L. example. This is the case also for "H-infinity," a highly mathematical so-called design procedure for linear time-invariant feedback control problems.

Fuzzy Logic, H-infinity, and neural networks and expert systems provide many opportunities for paper-publishing and government grant solicitation. There is such a huge number of so-called researchers who are "driven" by the need to write papers! These are convenient vehicles for this purpose. There is no concern for practicality. For example, the *IEEE Transactions on Automatic Control*, gave their best practical paper award, a few years ago, to a paper authored by two professors from the prestigious CalTech, plus one visiting professor from Sweden, and the design had no simulation whatsoever.

When a colleague of mine simulated their design, he found it to be instable. He notified them. They claimed a misprint, and gave him another design. He tried it and found it to be fantastically underdamped and with four infinite-bandwidth, high-gain (72 dB) compensating amplifiers. And this design theory is being extensively taught in graduate courses in the universities! Most Professors of Feedback Control in Electrical Engineering Departments in the universities (it is somewhat better in Mechanical Engineering) know extremely little about practical control systems, and really do not care—so long as they get government grants.

ISAAC HOROWITZ
Boulder, Colo.

Mr. Horowitz: On the many, many Fuzzy Logic papers filled with hype, I agree with you. But soon we will see GOOD F.L. systems; more later. Meanwhile, every serious control engineer should study Mr. Horowitz's book "Quantitative Feedback Design Theory (QFT) Vol. 1"—I've bought a copy. Request a brochure from the author at (303) 499-5357 or e-mail: horowitz@schof.colorado.edu—RAP

Dear Bob:

I am enclosing an article from *Design News* that covers the new Whirlpool fridge. It appears they are using Fuzzy Logic for adaptive defrost control. I find this somewhat humorous as I have been working in the HVAC controls business for 10 years and we have always used adaptive PID control in our designs. Does this mean we have been using Fuzzy Logic without even knowing it? I still think I could make the Whirlpool defrost work better without Fuzzy Logic. I kind of agree with you—on a lot of the applications, only the logic of their reasoning is fuzzy.

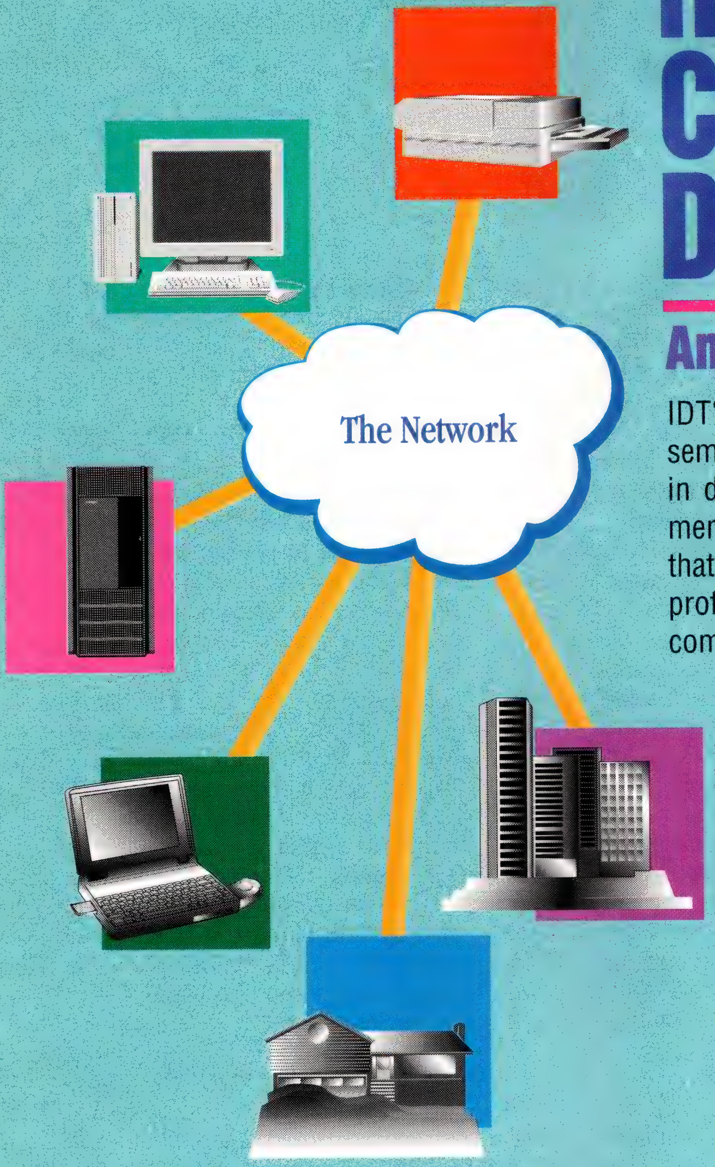
On the subject of *The Audio Critic*, I must disagree with their debunking of myths. I have been a high-end audio enthusiast for a long time and to claim that all amps of similar specs sound the same is absolutely false (*The Audio Critic* has claimed this for some time). What I have discovered is that most high-end amps, particularly vacuum-tube amps, are much more sensitive to loading of the inputs and outputs than mid-fi equipment. Therefore, the length and impedance of the cables you use to interconnect the equipment can have a profound effect on the sound. But to say that you can insert several different amps into the same system using the same cables and have them all sound the same (assuming similar specs) is without foundation. Sounds good in theory, though.

The so-called "holographic" imaging capabilities of high-end components (vacuum tubes in particular) are very real and I haven't been able to duplicate the results with any mid-fi equipment. Maybe there is "magic in the tubes". Anyway, I just thought I would throw in my own hobbyist observations for what they are worth.

I have been building my own audio equipment for 22 years and I have a BEE from Georgia Tech ('84). If you really share *The Audio Critic's* views, don't feel bad. I studied under W. Marshall Leach at Tech and he believes audio amps of similar specs sound the same, too. Maybe you just have to know what to listen for; until I heard the imaging magic of a system done right, I also was an unbeliever.

SAMUEL E. JONES
Systems Engineer
Automated Logic
Marietta, Georgia

I don't recall saying that "audio amps of similar specs sound the



HIGH-SPEED COMMUNICATIONS DESIGN SOLUTIONS

An IDT Datacom Seminar

IDT's "High-Speed Communications Design Solutions" seminar provides information on the latest developments in datacom technologies and the innovative specialty memories, RISC microprocessors, and ATM-specific ICs that support them. This seminar is a must for engineering professionals involved in designing next-generation datacom systems or evaluating design options.

SEMINAR OUTLINE

8:00 a.m. – 1:30 p.m., Lunch included

I. **IDT ICs for Datacom Systems**

II. **ATM Systems**
- Low-cost ATM interface card using a new SAR IC
- FIFOs and Multi-Port Memories in ATM switches

III. **Routers**
- An Ethernet-to-ATM router design
- Using Orion™ in a high-performance bridge/router
- A router for mixed voice and data traffic

IV. **Portable Applications**
- Components for PCMCIA cards
- A new highly integrated RISC CPU

SEMINAR LOCATIONS

CALIFORNIA

Encino	October 27
Costa Mesa	October 26
San Diego	October 25
Santa Clara	October 20
Sunnyvale	October 25

COLORADO

Thornton	October 11

CONNECTICUT

Southbury	October 12

ILLINOIS

Chicago	October 11

MARYLAND

Gaithersburg	October 4

MASSACHUSETTS

Chelmsford	October 6
Marlboro	October 13

MINNESOTA

Minneapolis	October 6

NEW JERSEY

Fairfield	October 5

NORTH CAROLINA

Raleigh	October 4

TEXAS

Dallas	October 12

CANADA

Ottawa	October 5

RESERVE YOUR PLACE TODAY!

CALL (800) 345-7015

and press "3" for FREE Seminar Registration

Integrated
Device Technology, Inc.

same." I'm just a skeptic on all high-tech audio equipment. The only thing I'm an expert on is the splicing of speaker wires.—RAP

Dear Mr. Pease:

A few issues ago you wrote a comment about how "tube sound" could be implemented by including circuitry to produce second-harmonic distortion in a transistor circuit that would otherwise produce relatively clean sound.

I have been thinking about trying this, and I was hoping you might have a simple design you would like to share. Ideally, the distortion would be adjustable and would generate only even harmonics. Ok, Bob, what kind of tricks do you have up your sleeve this time.

JAY TS
Director
Metran Technology
Tampa, Fla.

Sorry, Jay, I don't know the tricks of how to start with a clean solid-state amplifier and convert it to "the vacuum-tube sound." It's not just the distortion, it's the soft damping and the clipping, too. Can any reader recommend some technical article on this?—RAP

Dear Bob:

Your article in the Feb. 7 issue on quality scored a bullseye! While in the U.S. Air Force, I was subjected to Deming's philosophy. It was just plain common sense, nothing earth-shattering.

Imagine what would happen if the "No Test" mentality is extended to other industries. Publishing companies can get rid of editors because all of the writers' work would be error-free. Computer software would never give erroneous results or fail to work. Some industries are not suited for Deming's ideas.

I was wondering if you could do an article on mean time between failure (MTBF). I recently saw a new disk drive advertised to have a MTBF of 500,000 hours. That's over 50 years. I'm interested in knowing how MTBF is determined for products. I don't believe that the 500,000 hours was determined from direct testing. Keep up the great work!

MIKE SUTTON
Santa Clara, Calif.

You might ask the manufacturer how the MTBF was computed. Also, you can ask how the observed failure rate compared to the estimates when they ran life tests.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Burr-Brown 1994—
Applications Seminar

Learn—Solutions to problems in noise reduction, signal conditioning, isolation, sensor interfacing, digitizing, and more—all in an informative **ALL-DAY** session.

Presented by—Senior Design and Applications Engineers using inputs from our industry experts… Jerry Graeme and Jim Naylor.

Receive—Seminar Notebook
• New Product Guide • **FREE** Samples
• Data Sheets • Engineering Pad
• Spice & Filter Disks • EE Pocket Reference • Applications Handbook.

Cost—$35.00 includes lunch and all materials.

APPLICATIONS SEMINAR GREAT IDEAS 1994

Locations:

Anaheim, CA	12/06	**Houston, TX**	11/17	**Rochester, NY**	10/03
Atlanta, GA	10/13	**Indianapolis, IN**	11/01	**San Jose, CA**	12/02
Austin, TX	11/16	**La Jolla, CA**	12/05	**Seattle, WA**	12/01
Boston, MA	10/11	**Long Island, NY**	10/05	**Tampa, FL**	10/14
Chicago, IL	11/14	**Minneapolis, MN**	11/04	**Toronto, CAN**	10/21
Cleveland, OH	10/31	**Montreal, CAN**	10/19	**Vancouver, B.C.**	11/30
Greenwich, CT	10/17	**Newark, NJ**	10/06	**Washington, D.C.**	10/12
Dallas, TX	11/18	**Ottawa, CAN**	10/20	**Woodland Hills, CA**	10/12
Detroit, MI	11/03	**Philadelphia, PA**	10/07		
Denver, CO	11/28	**Phoenix, AZ**	12/09		

Sign Up Today—Call **(800) 548-6132** to register—now!

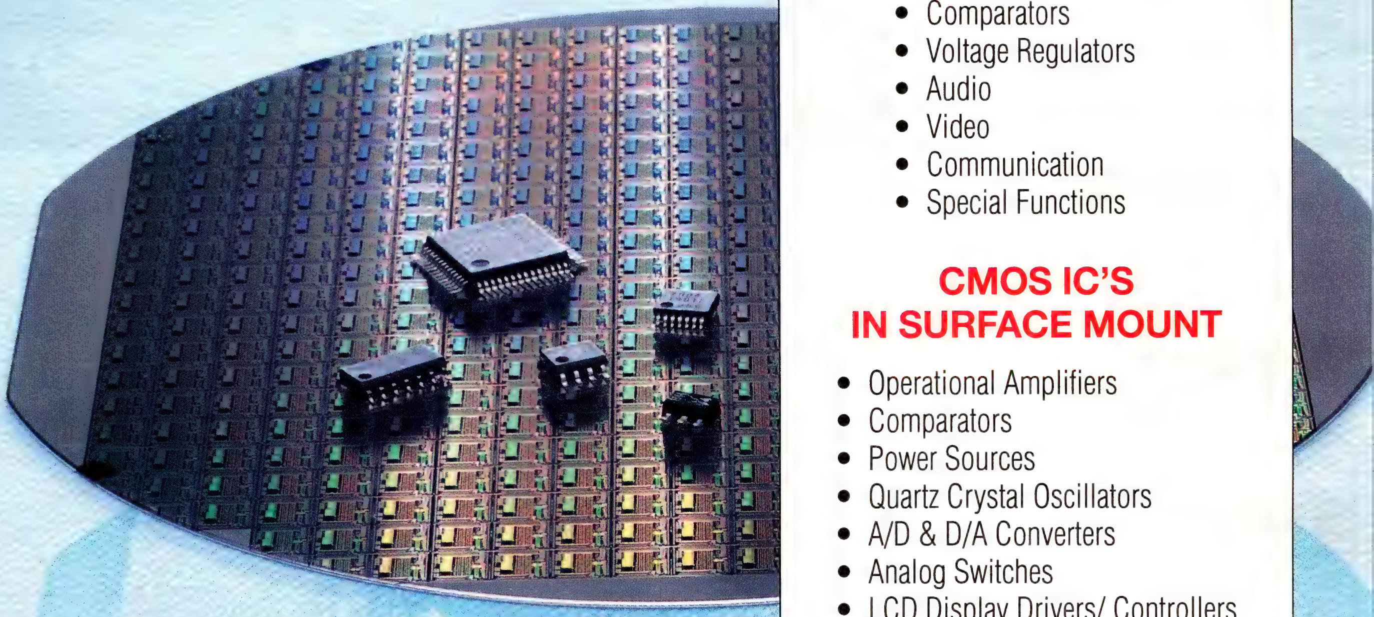
BURR-BROWN®

Burr-Brown Corp. • P.O.Box 11400 • Tucson, AZ 85734

READER SERVICE 226
READER SERVICE 227 OUTSIDE U.S.

New JRC

Leads the Way in Surface Mount Linear IC's



BIPOLAR IC'S IN SURFACE MOUNT

- Operational Amplifiers
- Comparators
- Voltage Regulators
- Audio
- Video
- Communication
- Special Functions

CMOS IC'S IN SURFACE MOUNT

- Operational Amplifiers
- Comparators
- Power Sources
- Quartz Crystal Oscillators
- A/D & D/A Converters
- Analog Switches
- LCD Display Drivers/ Controllers
- Real Time Clocks
- Radio/Communication
- Audio

All New JRC BiPolar and CMOS IC's are available in Surface Mount and Thru-Hole Packages.

New JRC is one of the largest manufacturers of BiPolar and CMOS IC's in the world. Over 130 million are produced each month. Surface mount devices represent 80% of the total.

★ ***Distributors wanted throughout the United States.***

For additional information or to request samples, please call NJR at (415) 961-3901 or our Representative in your area. NJR Representatives are located throughout the USA and Canada.

JRC

NJR CORPORATION
A SUBSIDIARY OF NEW JAPAN RADIO COMPANY, LTD.
340-B East Middlefield Rd. • Mountain View, CA 94043
Telephone (415) 961-3901 • FAX (415) 969-1409

READER SERVICE 197

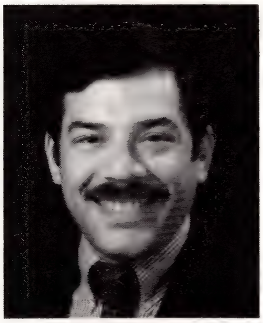
PC GRAPHICS WATCH

SET-TOP STANDARDS

FRANK SCHWARTZ, MAINSTREAM CONTROL INC.

The VESA Open Set Top (VOST) workgroup is currently defining the standards for the interactive digital set-top box, which is the hardware that controls the interface between the home television and the telephone and cable service providers. The open architecture defined by the group is based on a series of building blocks, with each block supporting a broad set of open options. The blocks are connected by a network that supports a digital transfer protocol and an optional analog signal. They can be standalone (in their own enclosure) or included in a TV, PC, or other device.

The VOST group is striving to develop set-top hardware standards that make business sense as well as technological sense. From a business standpoint, widely accepted standards decrease market fragmentation, help stimulate industry growth, reduce and/or redirect research and development costs, and assure manufacturers of wider market acceptance for their products. Standards will offer service providers an increased number of hardware suppliers, since suppliers will have a consistent interface and base platform to build upon. From a technological perspective, VOST standards will supply a consistent interface, connector, and configuration method, as well as a template for features yet to be defined. The standards also will provide an upgrade path and allow for different price points and product differentiation. Both the TV- and PC-oriented viewpoints will be addressed as well.



The VOST standards plan to include an equipment interface that's consistent, regardless of the transmission medium. This consistency benefits service providers by reducing the installation and maintenance complexities and by providing transportable end-user equipment. VOST standards also will describe the placement and interconnection of security features, such as descrambling, encryption, and decryption.

Another facet of the VOST standards is its consistent hardware platform for software developers, widening their market and reducing cross-platform development issues and development costs. The group is working closely with set-top software standards organizations, such as the Digital Audio-Visual Council (DAVIC) and the Interactive Multimedia Association, to ensure that the hardware and software standards are compatible. End users will be able to select standard set-top devices from a host of vendors, with differing price points and features, that are interoperable and transportable.

Currently, about 100 companies are participating in the standard generation. They include manufacturers of cable boxes, computers, connectors, consumer electronics, set-top boxes, and semiconductors; cable television, telephone, and telecommunications companies; and database, network, and operating-system vendors.

The VOST organization includes three technical working groups (TWGs): Platform Architecture, Liaison, and Marketing. The groups will spawn other TWGs as they define the requirements for the standards.

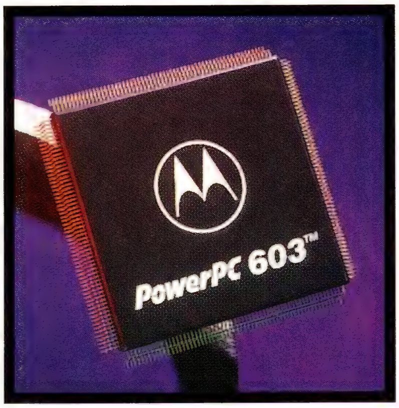
The Platform Architecture TWG is accepting proposals for the set-top box system architecture. Currently, the TWG is developing a prototype for evaluation by VOST participants. The architecture being defined includes a network interface unit, a subscriber routing-control unit, and a peripheral-interface network that connects an audio-video interface unit, a game interface, a decompression unit, and other peripherals.

The Liaison group interfaces with external standards organizations working on other aspects of the set top. Such organizations include the FCC, the IEEE (802 hybrid fiber and coaxial networks and P1394), EIA/NCTA (CEBus, AVBus, protocols), MPEG (I/II decompression), IMA (protocols), DAVIC (video-on-demand), and the Mmultimedia Communications Forum (quality of service), among others. The Liaison group arranges member exchanges, standards data-gathering, tutorials, and other interorganizational activities.

The Marketing workgroup handles the finalization of standards documents, white papers, press releases and tours, and other documents, and works with application developers and end users of the set-top box.

The first version of the VOST standard, expected during the first quarter of next year, will be an architectural description of the set-top-box building blocks. Subsequent revisions will describe the functional content of each building block, starting with the network interface unit, subscriber routing-control unit, peripheral-interface network, decompression unit, game interface, and audio-video interface unit.

For more information on the VOST standard, contact the VESA office at (408) 435-0333, or Frank Schwartz, VOST committee chairman at (415) 321-1860.



If our FastScan ATPG can handle a chip like this, just imagine what it will do for your ASIC or IC.

Like every other product manufactured by Motorola, the PowerPC 603™ family of microprocessors is subject to the company's rigorous Six Sigma quality program.

So, not surprisingly, testability was a major issue with the PowerPC 603 family. Nothing but the best would do.

No small task in a chip with over 1.6 million transistors. How do you get maximum fault coverage to ensure quality, yet minimize your test vectors to boost productivity?

Simple. You turn to Mentor Graphics' FastScan™ ATPG, the test pattern generation tool now used by IC and ASIC developers throughout the world. In the PowerPC 603, FastScan not only produced maximum fault coverage with minimum vectors, it did so within an extremely tight design schedule.

In fact, it performed so well, Motorola has selected it as the ATPG tool of choice for the entire PowerPC 603 family project.

Better yet, FastScan is just one of our standard-setting tools that deliver a full-chip test solution for virtually any IC or ASIC, large or small.

Everything from boundary scan insertion at the VHDL level to full ATPG for non-, partial-, and full-scan designs to exhaustive fault coverage analysis.

So put us to the test, the way the PowerPC 603 microprocessor did. Phone 1-800-547-3000, dept. 327 for more information on Mentor Graphics' Full-Chip Test. Or E-mail us at: dft_mgc@mentorg.com.

Mentor Graphics®

We mean business.

PowerPC 603 and the PowerPC name and the PowerPC logotype are trademarks of International Business Machines Corporation, used under license therefrom.

READER SERVICE 204

Bandwidth Must Meet Rising Demands

Data-intensive applications are driving the need for higher disk-system throughput.

BY DOUGLAS FIELDS

Adaptec Inc., 691 South Milpitas Blvd., Milpitas, CA 95035; (408) 945-8600.

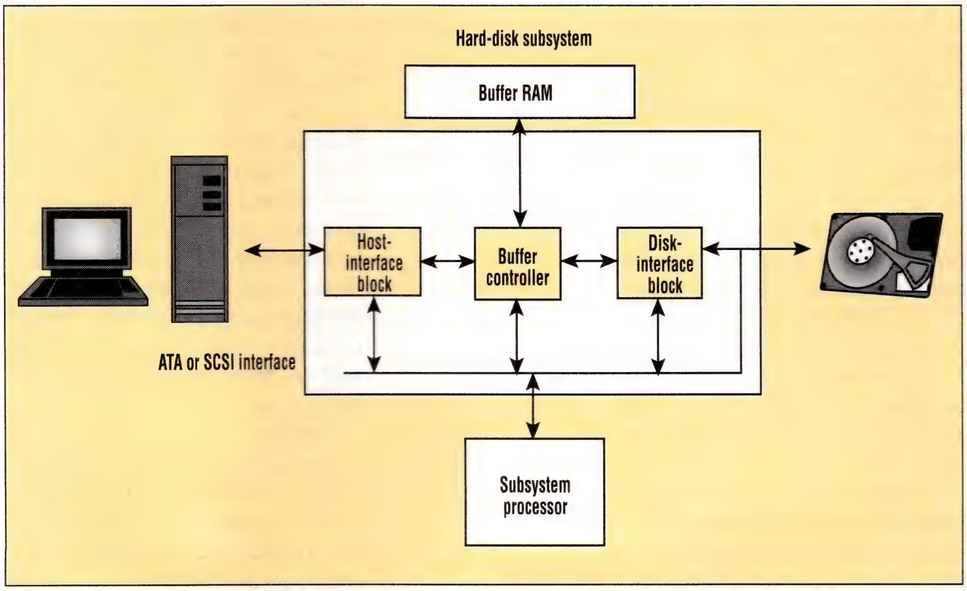
Today, graphical user interfaces, multimedia applications, and the rising popularity of networking have mounted unrelenting pressure on mass-storage subsystems. With such pressure comes demands for more capacity, faster access, and faster data-transfer speeds. In turn, these demands are putting pressure on the disk-buffer subsystem that stands between the host and the disk.

For current and future PCs to support the latest innovations in applications and networking, disk drives and controllers will require a more streamlined and faster data exchange. New host-to-disk subsystem interfaces are ramping up the performance at that end, and innovative disk arrays are providing faster data movement on and off the disks. The critical path is likely to become the buffer unless it, too, can be pushed to a higher bandwidth.

Host automation and automated data-flow techniques will improve overall disk subsystem performance. Wider data paths between the buffer controller and buffer memory can substantially increase buffer bandwidth. Ultimately, all of these techniques, plus the adoption of faster buffer-memory components, will have to be put in place to keep the flow high enough to support data-intensive applications.

Attaining the bandwidth required by the industry can be accomplished through faster host-disk subsystem interfaces, faster disks, a wider bus interface between buffer RAM devices for use in the disk buffer, and more automated operations that demand less intervention by the disk subsystem's microprocessor.

1. A hard-disk subsystem combines three data-flow channels—the host interface, the buffer controller, and the disk interface. The buffer controller must accommodate the sum of the host and disk data rates to avoid a bottleneck.



With the increased use of multitasking operating systems, such as Microsoft's upcoming Windows 4.0 and IBM's OS/2, the buffer subsystem will need multiple active segments handling different, concurrent processes. Efficient multitasking support depends upon effective command queuing and minimal command overhead.

Error detection and correction approaches must address the fault-tolerant requirements of network servers and high-end PCs. Error-correction-code (ECC) methodologies must correct large burst errors (of more than 100 bits at a time) and provide sector ID correction. In addition, systems will have to identify corrupt synchronization bytes. And forthcoming disk systems must support large block transfers, larger than 16 kbytes per request for example, as well as sector sizes up to 2 kbytes.

To better understand what will ultimately be required, it's helpful to examine each factor that contributes to increased disk-system pressure. A page of text (60 columns by 40 rows) is represented by 19,200 bits. But a typical 14-in. color video screen (640 by 480 pixels) containing a full-size, bit-mapped graphic image (at 8 bits per pixel) is described by nearly 2.5 million bits or 128 times more data. As a result, applications such as image processing, and desktop publishing, which use bit-mapped graphics, require much more storage capacity. In addition, when scrolling through a compound document, the data flow per page can easily overcome the disk subsystem's data-transfer speed.

A graphical user interface (GUI) such as Windows or OS/2 requires more bandwidth to support its information format than a text-based operating system. Moreover, applications written to run on top of a GUI-based operating system also require added bandwidth to service them.

The bandwidth problem is further exacerbated by networked systems. Servers supporting I/O-intensive applications and/or large groups of concurrent users must keep pace with demand for data. The situation becomes even more drastic as multimedia-type applications are added to the network.

By examining the changes in disk-drive product requirements from 1993 to 1994, a compelling case can be made that buffer bandwidths of at least 35 Mbytes/s is now required *(see the table)*, and future systems will have to handle 70 Mbytes/s and more.

DISK-DRIVE REQUIREMENTS

Host	Disk	Total buffer bandwidth
Fast SCSI (10 Mbytes/s) 1993	8 Mbytes/s	18 Mbytes/s
IDE Mode 3 (8 Mbytes/s) 1993	5-8 Mbytes/s	16 Mbytes/s
Fast & Wide SCSI (20 Mbytes/s) 1994	10-15 Mbytes/s	35+ Mbytes/s
Narrow Fast-20 SCSI (20 Mbytes/s) 1994	10-15 Mbytes/s	32+ Mbytes/s
IDE Mode 3 (16 Mbytes/s) 1994	10 Mbytes/s	26+ Mbytes/s
Serial Extensions (20 Mbytes/s) 1994	10-15 Mbytes/s	32+ Mbytes/s
Wide Fast-20 SCSI (40 Mbytes/s) 1995	10-15 Mbytes/s	52+ Mbytes/s
Fibre Channel (100 Mbytes/s) 1995	10-15 Mbytes/s	70+ Mbytes/s

Ideally, the relationship between host computer and disk subsystem would involve minimal host intervention, and minimal latency between the data traveling from the host to the disk and the data actually being written to the disk. In the real world, though, some host computer overhead as well as some latency will exist. But both situations can be mitigated.

One of the side effects of higher transfer rates is the propensity for more data errors.

The block diagram of a disk subsystem reveals three transfer channels *(Fig. 1)*. Data moves from the host system to the controller's host interface block. At the same time, data travels from the buffer controller to the buffer RAM and the disk-interface block. Eventually, the data gets passed to the drive.

If the host-to-disk system interface is fast SCSI, then that channel must accommodate a data-transfer rate of 20 Mbytes/s. Similarly, a drive capable of transferring 100 Mbits/s would need a channel that could handle 12.5 Mbytes/s. To keep the buffer controller from becoming a bottleneck, it's minimum bandwidth would have to be 32.5 Mbytes, the sum of the previous two rates.

Host-interface automation helps reduce the amount of host intervention. For example, a SCSI host adapter that minimizes host involvement and speeds SCSI command execution could help maintain higher transfer rates between the host and the disk drive. Features such as SCSI command chaining diminish host intervention by combining commands into command groups.

The SCSI interface also will have automated hardware with low command overhead. Using RISC or low-cost sequencer technology offers designers both flexibility in firmware design and optimal disk-drive performance. An effectively designed automated interface lets the hard-disk controller quickly process SCSI commands without microprocessor intervention.

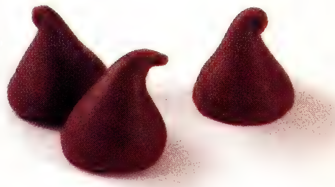
Because the same disk drive will be used in various applications, the automated interface should have a flexible command set. As a result, firmware engineers will be able to change the disk drive's host-interface response. For I/O-intensive RAID applications, the firmware engineer could program the interface for multitasking and host control of the target interface. For multimedia applications, the host interface could be reprogrammed for long block transfers with latency control and no host microprocessor intervention.

Similarly, if the subsystem processor were involved less frequently with the host interface, buffer control, and disk-interface blocks, it could spend more time serving the disk and keeping the data flow at higher levels.

Various approaches have been developed to automate data flow. These involve making the controller chip more intelligent so that the subsystem microprocessor is called upon less frequently. One such approach is Adaptec's Automatic Data Flow Management (ADFM). In essence, it automatically controls the flow of data between the host and the disk while requiring little or no involvement from the subsystem processor. Host and disk transfers are throttled automatically on a sector-by-sector or block-by-block basis, depending upon the state of the buffer. And ADFM is a vehicle for automating concurrent non-threaded functions, such as disk read-ahead and auto-write.

In the ADFM approach, the buffer can be divided into concurrently operating functional segments, such as write, read, and auto-write. Using buffer counter transfer registers (BCTRs), the buffer controller can stay abreast of the number of data blocks entering or leaving the buffer, and automatically control the data flow to prevent underflow or overflow conditions *(Fig. 2)*. This approach minimizes data-flow intervention by the subsystem microprocessor.

The width of the bus between the buffer controller and the buffer RAM is a critical bandwidth element. Going from 8 to 16 bits virtually doubles the buffer bandwidth, and moving



CHOCOLATE CHIPS

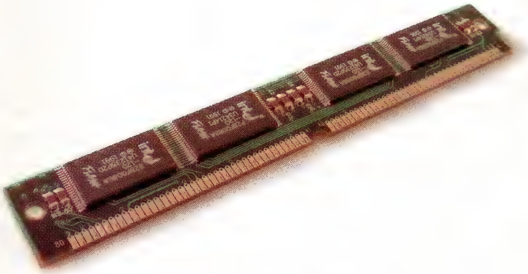
{ Bites }

CHOCOLATE CHIP MODULE

{ Mega Bites }

FLASH CHIPS

{ Bytes }



FLASH MODULE

{ Megabytes }

FLASH SIMMS = MEGABYTE FLEXIBILITY.

Why Flash Modules?

Chocolate or flash memory: either way, if you want it in big bytes, it's easier and more efficient to go modular. When you design for flash modules, you stay flexible: you can easily configure, reconfigure, and upgrade. And since each module comes to you fully tested, it's a true plug-and-play proposition. We'll program the memory at the factory if you like, or you can program it when you configure your system. And of course, you or your customer can program it (or reprogram it) in the field.

Part Number	*Density*	*Organization*
SM732A4000	*16MB*	*4M x 32*
SM732A3000	*12MB*	*3M x 32*
SM732A2000	*8MB*	*2M x 32*
SM732C2000	*8MB*	*2M x 32*
SM732C1000B	*4MB*	*1M x 32*
SM732A1000	*4MB*	*1M x 32*
SM732C512	*2MB*	*512K x 32*
SM732A512	*2MB*	*512K x 32*
SM732C256A	*1MB*	*256K x 32*
SM732A256	*1MB*	*256K x 32*

All modules are SIMMs with 90/100/120 ns access times.

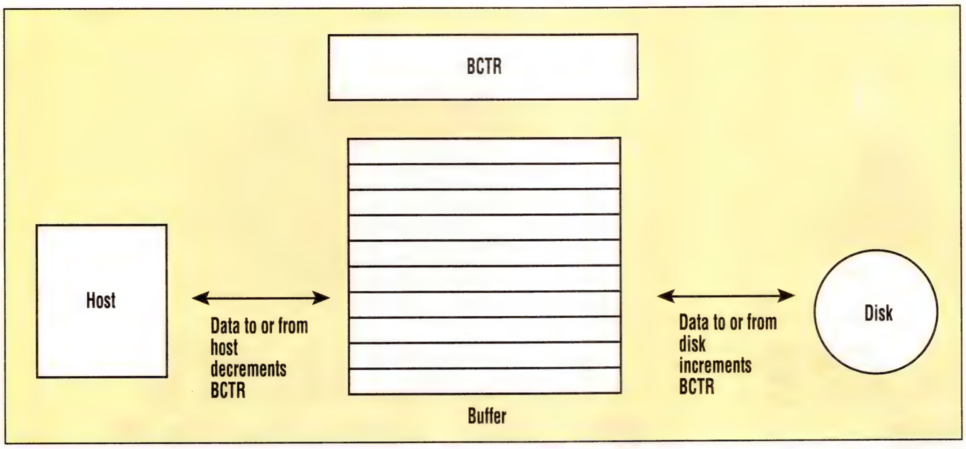
Why SMART Modular Technologies?

Innovation: How about an on-board voltage converter that lets you use 12-volt flash memory in a 5-volt system—or an on-board power supervisor that prevents spurious writes during power-up and power-down? And experience: SMART makes more flash modules than anyone else in the world. That makes us easy to deal with on price (just ask), availability (now), quality (100% testing ensures it), and selection (the chart at left is just a small sample). We can also design custom SIMMs for you. Just ask. You can get a complete selector guide by calling 1.800.655.SMART (1.800.655.7627). If you have technical questions, you can get answers by calling us at 1.800.536.1231, or by faxing 510.623.1434.

Flash Memory Modules. The SMART Way.

SMART
Modular Technologies

READER SERVICE 131


BCTR
Host
Data to or from host decrements BCTR
Buffer
Data to or from disk increments BCTR
Disk

2. As part of the ADFM scheme, the buffer counter transfer registers (BCTRs) allow the controller to throttle data flow without processor intervention. For example, when the host writes data to the disk, the BCTR is initialized to a value that represents the number of blocks. Each block transfer increments or decrements the counter, depending on the direction of data flow.

to 32 bits becomes another big jump. Meanwhile, the RAM devices themselves are being scrutinized for incremental bandwidth increases. For example, enhanced data RAMs promise to significantly enhance speed. Coupled with a shift to a 32-bit bus width, the over-70-Mbyte/s buffer bandwidth requirements for next-generation drives are readily attainable.

One of the side effects of higher transfer rates is the propensity for more data errors. On-the-fly ECC will be hard-pressed to keep pace with the new, higher performance subsystems. It's mandatory that ECC support disk areal densities of at least 1 Gbyte/in.^{2}. The higher bit density will increase errors in reading sector IDs, and correction may have to support over 100 bits for single- and multiple-burst errors. Generally speaking, few users, if any, would be willing to trade off data integrity for increased speed, certainly not after being accustomed to having both.

Adaptec employs an advanced 297-bit Reed-Solomon ECC system. As applied in the AIC-83XX disk-controller family, the ECC block generates check symbols for the data field during a write operation and generates the syndromes for the data and check fields during a read operation. It calculates error locations and patterns, and handshakes with the buffer manager to perform the necessary corrections. In addition, the block performs on-the-fly error correction so that if a sector is in error, it's corrected even as the next sector is being read.

To support a smaller overhead, the check field can be shortened from 33 to 12 check symbols in increments of three (i.e., 30, 27, 24, and so on). Shortening the check field reduces the distance of the code and, therefore, its correction capability.

Errors longer than the guaranteed detectable burst length can be caught, and in some cases, corrected. Lastly, hardware correction uses only four check symbols for each interleave. Increasing the number of symbols, however, won't improve hardware correction or detection.

To determine the minimum data block size, one must consider the time required to perform a worst-case hardware error correction, such as a double error correction in all three interleaves. This, in turn, depends on the number of check symbols as well as the response time of the buffer manager in acknowledging a correction. It also depends on the gap from the end of the data ECC check field to the start of the next field. In general, a minimum data block size of 180 bytes is acceptable. But if the buffer memory bandwidth is so tight that correction can't be completed before the end of the data field of the succeeding data block, a correction overrun will occur.

An ECC field can be applied to sector ID protection. With greater areal densities, there's a greater possibility of getting a "sector ID not found" response. At best, it may require doing a retry or two; at worst, it means lost sector data. With ECC capable of identifying a sector with up to six bit errors in the ID, the overall reliability increases significantly. Similarly, with increased areal density, there's a greater chance of a missing synchronization byte. To that end, an error-tolerant sync-byte detection will help combat the problem.

As these techniques, or others like them, are applied to future disk subsystems, other trends will emerge. There will be a move toward "headerless" disk storage, meaning that cylinder and track IDs will be eliminated. The result will be lower data overhead and more usable capacity on the disk. There also will be support for blocks larger than 16 kbytes, which make use of "blocking factors" to match locations to physical sector requirements. Moreover, the current 512-byte sector size will grow to 1 and 2 kbytes. Windows NT, for example, can work with 1-kbyte sectors, and some variations of Unix can handle 2 kbytes.

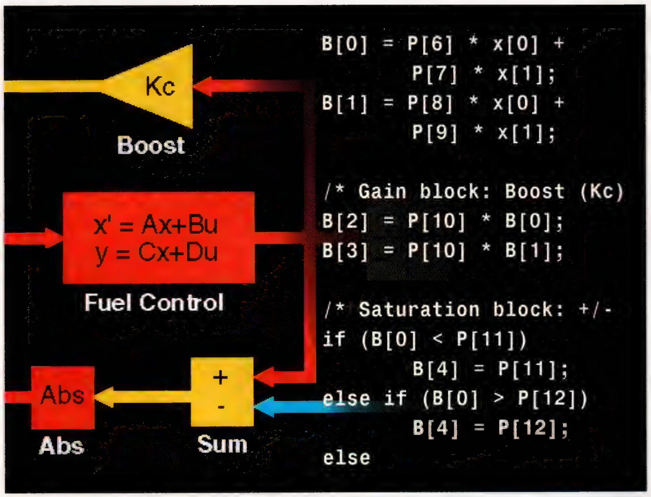
Thanks to Ken Chyang, Kuldip Shodhan, Rod Kirk, and John Eagle, who contributed to this article.

Douglas Fields, a product manager for SCSI and serial I/O products at Adaptec, holds a BA in engineering from Purdue University, a masters degree in engineering from the University of Utah, and an MBA from the University of California at Berkeley.

HOW VALUABLE?

HIGHLY	CIRCLE 540
MODERATELY	CIRCLE 541
SLIGHTLY	CIRCLE 542

When you need real-time code, a picture is worth a thousand lines.



```
B[0] = P[6] * x[0] +
        P[7] * x[1];
B[1] = P[8] * x[0] +
        P[9] * x[1];

/* Gain block: Boost (Kc)
B[2] = P[10] * B[0];
B[3] = P[10] * B[1];

/* Saturation block: +/-
if (B[0] < P[11])
        B[4] = P[11];
else if (B[0] > P[12])
        B[4] = P[12];
else
```

The Real-Time Workshop lets you create designs with SIMULINK blocks and move directly to hardware-in-the-loop testing — within minutes.

With the SIMULINK Real-Time Workshop, you can automatically generate many thousands of lines of C code from your block diagrams with the push of a button.

Real-Time Workshop's open architecture provides a development environment that enables you to rapidly implement and test your designs on your real-time hardware.

From block diagram to C code

You start by creating a continuous, discrete-time or hybrid model of your system in SIMULINK. Then you generate highly optimized, target independent C code that runs on virtually any floating point hardware.

Turnkey support

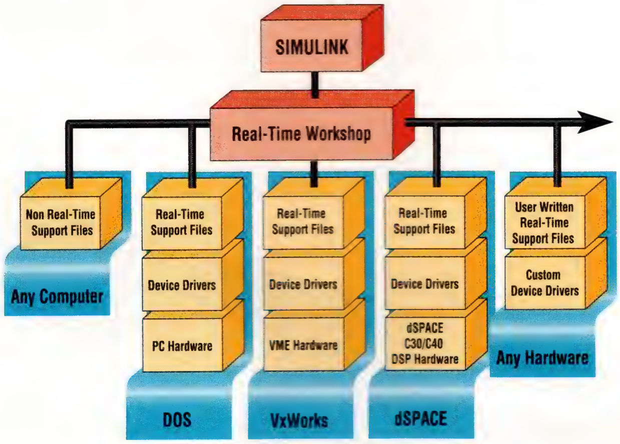
Device drivers provide out-of-the-box operation on supported hardware as well as all the information you need to run on hardware you select. Documented examples and device driver source code are included for:

- dSPACE DSP boards
- VxWorks real-time operating system with VME hardware
- PCs using commercially available I/O boards

Additional dSPACE software products provide complete rapid prototyping, including data monitoring and acquisition. With VxWorks, StethoScope provides data monitoring and acquisition.

Target your hardware

Real-Time Workshop goes beyond generating C code. Its real-time framework API provides an extensible build environment based on customizable makefiles. This enables you to use custom device drivers and to specify compiler and linker options.



When combined with support files and device drivers, the generated code can run on a wide range of target hardware.

SIMULINK®
Real-Time Workshop™

The Ultimate Technical Computing Environment™

MATLAB and SIMULINK seamlessly integrate computation, visualization, modeling and simulation on PCs, Macintosh, and UNIX workstations.

Powerful, versatile toolboxes

MATLAB Toolboxes provide specialized solutions for specific applications including:

- ***Nonlinear Control Design***
- ***Control System Design***
- ***Robust Control***
- ***μ-Analysis and Synthesis***
- ***Optimization***
- ***Signal Processing***
- ***Neural Network***
- ***Model Predictive Control***
- ***Frequency Domain System Identification***
- ***Higher-Order Spectral Analysis***
- ***SIMULINK Accelerator***

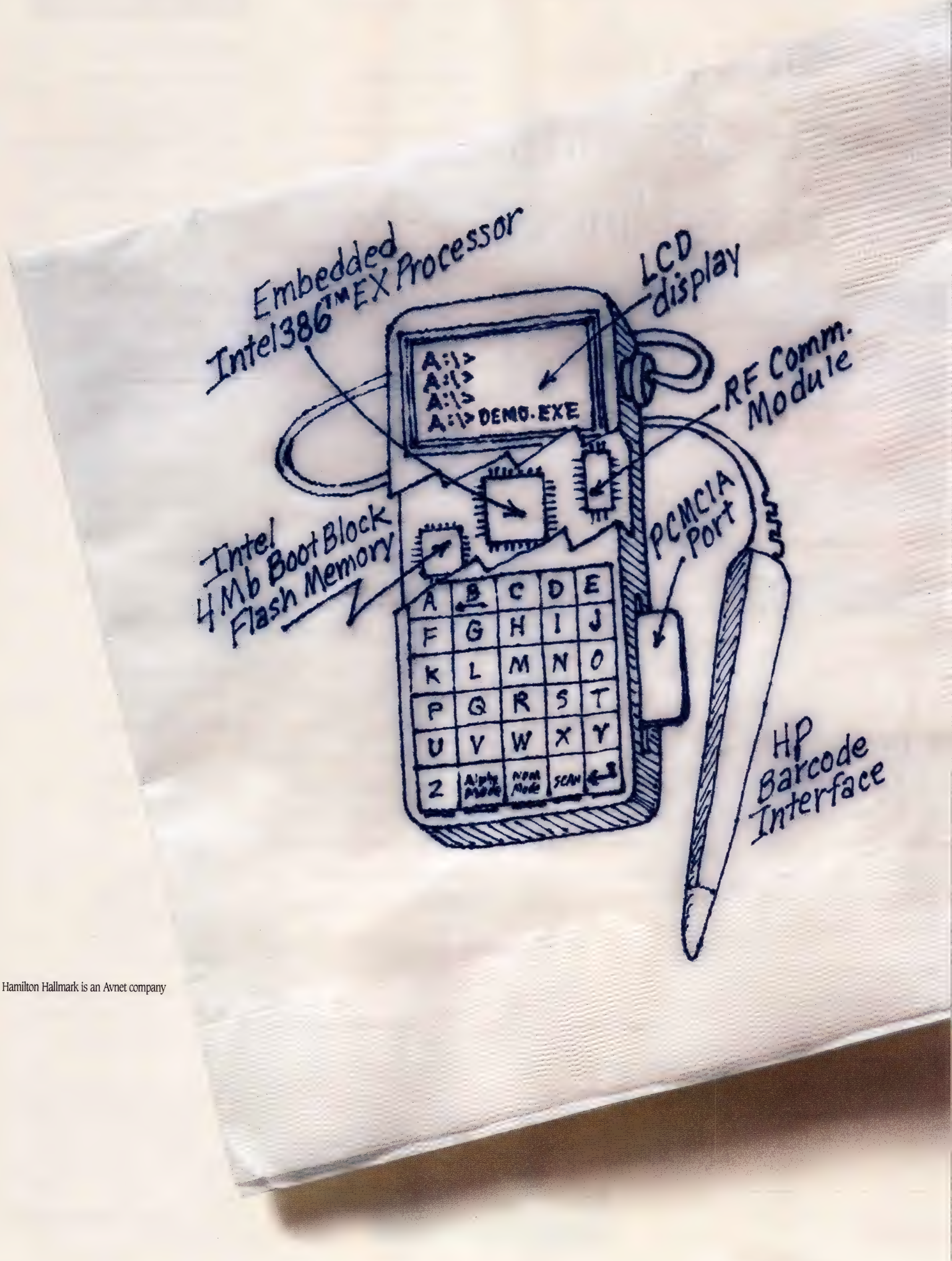
Call today: 508-653-1415

The MATH WORKS Inc.

24 Prime Park Way, Natick, MA 01760-1500
Tel: 508/653-1415 Fax: 508/653-6284
Email: info@mathworks.com
Mosaic -- http://www.mathworks.com

The MathWorks is represented in the following countries:
Australia: +61-2-922-6311 • Brazil: +55-11-816-3144
France: +33-1-45-34-23-91 • Germany: +49-241-26041
India: +91-80-2-260-260 • Israel: +972-3-561-5151
Italy: +39-11-24-85-332 • Japan: +81-3-5978-5410
Portugal: +34-3-415-49-04 • Scandinavia: +46-8-15-30-22
Spain: +34-3-415-49-04 • South Korea: +82-2-517-1257
Switzerland: +41-31-998-44-11 • Taiwan: +886-2-501-8787
For Belgium, Luxembourg, The Netherlands, United Kingdom and Republic of Ireland call Cambridge Control, Ltd: +44-223-423-200 **or** Rapid Data, Ltd: +44-903-821-266

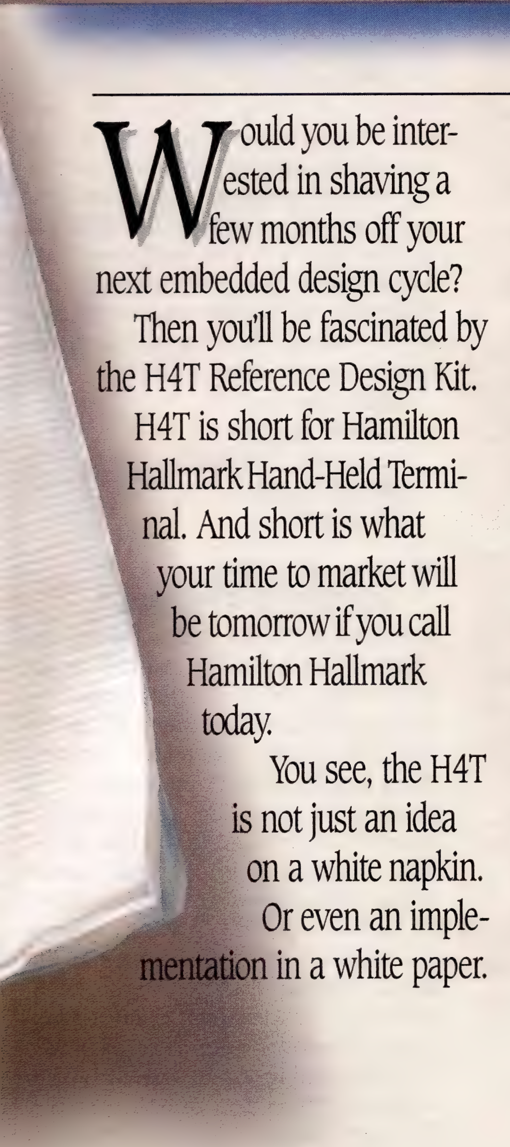
MATLAB and SIMULINK are registered trademarks of The MathWorks, Inc. Real-Time Workshop is a trademark of The MathWorks.



Hamilton Hallmark is an Avnet company

Technology by Intel.

Inspiration by Hamilton Hallmark



Would you be interested in shaving a few months off your next embedded design cycle?

Then you'll be fascinated by the H4T Reference Design Kit.

H4T is short for Hamilton Hallmark Hand-Held Terminal. And short is what your time to market will be tomorrow if you call Hamilton Hallmark today.

You see, the H4T is not just an idea on a white napkin. Or even an implementation in a white paper.

It's a working application, centered around the Embedded Intel386™ EX Processor and incorporating Intel Flash Memory and all the other technologies you see called out. Including Hewlett-Packard's SmartWand bar code reader.

The Reference Design Kit comes complete with the schematics, firmware/software implementation details, BOM, data sheets, PCB layout, boot source code and detailed application note on which to base your next enhanced design.

Who initiated the H4T and worked closely with Intel to complete it? The engineers at our Technical Support Center.

The same engineers whose average of 15 years experience in the field makes them so adept at fielding your questions and understanding your problems.

So while it may surprise you to see such an application come from a distributor, the distributor it came from should be no surprise at all.

FOR A FREE H4T
WORKING APPLICATION
REFERENCE DESIGN KIT,
CALL 800-608-3434
TODAY.

HAMILTON HALLMARK

SYSTEM DESIGN NEWS

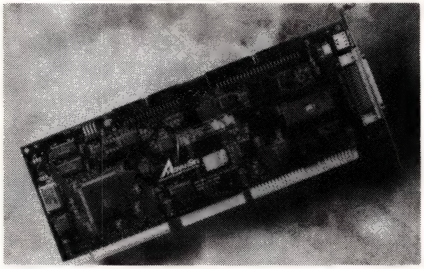
A novel frame-buffer memory called the 3D RAM, developed by Mitsubishi Electronics America, Sunnyvale, Calif., accelerates the performance of 3D graphics rendering by incorporating an ALU to speed up Z-buffer rendering. Overall, the chip can render 1.8 million 100-pixel triangles/s. In comparison, a system based on 2-Mbit video RAMs can only generate 210,000 triangles/s. Each 3D RAM contains about 10 Mbits, and supports a 1280-by-1024-pixel by 8-bit image. With 12 chips, a full 1280-by-1024-by-96-bit (double-buffered with Z) image can be supported, making it possible for the subsystem to deliver real-time, photorealistic images or virtual reality. Developed jointly with Sun Microsystems, Mountain View, Calif., the memory is internally organized as a 10-Mbit DRAM array connected to a 2048-pixel buffer through a 256-bit global bus. The DRAM array is further organized as four independent 2.5-Mbit DRAM banks, with each pair of banks sharing a 640-bit-wide serial-access memory that serves as a video buffer. The buffer is linked to the pixel ALU through 32-bit read and write ports that operate concurrently with the DRAM array on the internal bus, achieving a 76-Hz refresh rate. The ALU has four 8-bit raster-operation units, four 8-bit blend units, one 32-bit match comparator, and a 32-bit magnitude comparator. Internal data movements over the wide on-chip buses allow data to be moved from the DRAM banks to the pixel buffer at 1.6 Gbytes/s. Samples of the chip, housed in a 128-lead PQFP, will be available next quarter, with production expected in the first quarter of 1995. Sample quantities will sell for about $115 in the 15-ns buffer-cycle-time speed grade. Contact Mitsubishi at (408) 730-5900.

A highly integrated motherboard support solution for portable x86 systems can be found in the Diana three-chip from set VIA Technologies, Fremont, Calif. The set operates from 3.3 or 5 V and merges power-management, PCMCIA, and five previously discrete peripheral functions. One chip (VT82C425MV) provides base-motherboard logic functions; another (VT83C465) provides a full PCMCIA socket controller; and the third chip (VT82C406MV) includes the clock generator, a keyboard controller, a real-time clock, and glue logic. The 82C425 also provides a VL-Bus interface for high-performance I/O expansion, and has a sophisticated power-management unit and a local-bus IDE disk-drive controller. The VT82C465 provides a full implementation of the 2.0 release of the PCMCIA/JEIDA 4.1 card-sockets standard, and will support the ATA pin definition when used to communicate with an IDE PCMCIA hard-disk drive. An optional companion chip, the VT82C505, bridges the VL-Bus to the PCI bus. In large quantities, the Diana chip set will sell for about $20. Contact Dick Renne at (415) 683-3316.

A single-chip controller designed by Fujitsu Microelectronics, San Jose, Calif., allows designers to build ISA add-in cards that can be automatically configured by host-resident software. The MB86701 plug-and-play ISA controller conforms to the Intel/Microsoft PnP series of standards (version 1.0a) released in May (the more complete set of PnP standards are expected by mid-1995). It eliminates all manual hardware and software tweaking. One interesting feature is the chip's ability to map any access to a user-defined address on the logical device side. Consequently, the driver software can use memory-reference instructions to access a fixed-address register on the card, which in turn can speed up data transfers. To perform its job, the MB86701 communicates to a local serial EEPROM. The EEPROM maintains the card's resource-requirement data and other user-defined information such as Ethernet ID. The controller maintains configuration data for two interrupt requests, two DMA channels, two I/O chip selects, and two memory chip selects. Also included is a 4-bit I/O port that permits each pin to be used as an input or an output. Samples of the chip are available immediately. In lots of 10,000, the chip sells for $5.95 each. Contact Alex Goldberger at (408) 922-9000.

▼ SCSI HOST ADAPTER BOOSTS PERFORMANCE

The speed at which disk drives and other peripherals deliver data can be doubled using the ABP842 SCSI host adapter. Designed to work with systems running such high-performance operating systems as Windows 4.0 and NT, NetWare, and Unix, the adapter can process up to 255 simultaneous requests for data in its local memory. Existing adapters employ the system's local memory when processing more than four simultaneous requests. The ABP842 comes bundled with software that simplifies the installation configuration process. The adapter contains a SCSI ribbon cable and manuals. Available now, it costs $379.



AdvanSys Inc.
1150 Ringwood Ct.
San Jose, CA 95131
(408) 383-9400
▶ **CIRCLE 640**

▼ PowerPC ADDS MUSCLE TO SYSTEMS

The PowerPC 601 CPU forms the processing element that's built around the TPC-5510 platform. The system can handle either a 66- or 80-MHz chip in one of two form factors. The baby AT version includes a CPU upgrade or secondary-cache socket, three PCI slots, and five ISA slots. The Western Digital form factor board is similar but contains just two PCI slots and two ISA slots. Operating systems that are supported include System 7, AIX, OS/2, DOS, NetWare, PowerOpen, Solaris, Taligent, Windows, and Windows NT. Volume production of the TPC-5510 should start in the fourth quarter. Systems based on PowerPC 603 and 604 microprocessors should be available in the first quarter of next year.

Tatung Co.
2850 El Presidio St.
Long Beach, CA 90810
(310) 637-2105
▶ **CIRCLE 641**

You Need Tree City USA

City trees add the soft touch of nature to our busy lives. They cool our cities, fight pollution, conserve energy, give wildlife a home, and make our neighborhoods more liveable.

The trees on city property, along streets and in parks, are an essential part of the urban forest. To keep these trees healthy and abundant, your town needs an organized program for their care…an annual action plan to plant and prune the city's trees, and to maintain their health.

You can make a difference — by planting and caring for trees in your yard and in your neighborhood, and by encouraging your city government's community forestry program.

Support Tree City USA where you live. For your free booklet, write:
Tree City USA, The
National Arbor Day
Foundation, Nebraska
City, NE 68410.

The National Arbor Day Foundation

©1994 The FORCE logo is a registered trademark of FORCE COMPUTERS Inc.

it's not that we devote more time to our technology
or that we have more products to choose from

and it's not that we know so much more
about embedded systems

and it isn't our field engineers or their experience or the way they listen
and it's not that we continue to support a product
even after the technology changes

and it's not that we're ISO 9001 certified
but you would've asked
sooner or later

and it could be
that we have our own manufacturing and SMD production facilities

but it's not

it's everything

tel: 1-800-FORCE-99

FORCE COMPUTERS®

Circle 184 for Sales Representative
Circle 185 for literature

IF IT SHAKES
RATTLES OR ROLLS
OR SPINS RECORDS
PUSHES PULLS
COMPRESSES
TRANSFERS
MEASURES
PLACES
SHIFTS
PRINTS
DROPS
GRINDS
SWAPS
PLAYS
LIFTS
SPLITS
BAKES
CUTS
ETC.
ETC.
ETC.

WHY STOP IT?

Embedded systems don't just sit there–they *do* something. And when you're debugging them, often the last thing you want to do is stop the action.

That's why Orion's model 8800 provides *non-stop analysis*. With the 8800 you can set, reset, and refine triggers and view multiple real-time traces on-the-fly, without stopping or affecting your target.

No breakpoints, no hidden wait states. Just true target system timing and behavior. So you can find out what's really going on

Of course, when you do want to stop the action, the 8800 delivers with precise hardware and software breakpoints. Together with your choice of popular source-level debug environments, you get the control and visibility you're looking for.

CLIP-ON TO SURFACE MOUNT

Orion's 8800 is the only emulator that provides Clip-On Emulation™. This patent-pending probing technique allows you to clip-on to the growing number of designs using surface mount processors. And unlike other systems, Orion's Clip-On Emulation doesn't require special processor emulation modes.

ACCELERATE YOUR DEVELOPMENT

Orion's proven real-time development tools keep both you and your projects moving in the right direction. So if you want to get there faster, call right away.

800-729-7700

Supported Processors

MOTOROLA

68307 68306 68302
68EC000 68HC11

INTEL

80C196KB/KC/KD/KR/KQ/NT/NP

IBM

MC19610/11/12/14/20

ZILOG

Z182 Z181 Z180 Z80 Z84C15

ORION®
INSTRUMENTS

© 1994 Orion Instruments, Inc., 1376 Borregas Ave. Sunnyvale, CA. 94086 Tel: 408-747-0440 Fax 408-747-0688 All rights reserved.

READER SERVICE 202

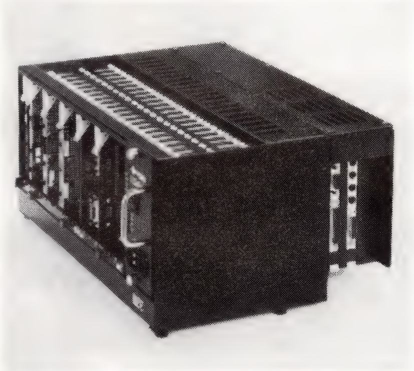
▼ PCMCIA FLASH FILE SYSTEM GETS UPGRADE

Based on the PCMCIA flash transition-layer (FTL) standard, Version 3.2 of the TrueFFS is a fully-compliant FTL flash file system needed to implement a PCMCIA architecture. TrueFFS has been tested with most versions of PCMCIA software to ensure compatibility in plug-and-play applications. The software occupies about 23 kbytes to handle the current crop of flash memory cards. TrueFFS enables read speeds in excess of 2 Mbytes/s and write speeds near the theoretical limit of flash components. Write speeds aren't affected by file fragmentation that occurs after extensive usage of a flash card. An automatic-wear-leveling feature transparently distributes the data evenly throughout the card to increase the card's life. Available now, version 3.2 of TrueFFS is available for $295.

M-Systems Flash Disk Pioneers
4655 Old Ironsides Dr., Suite 200
Santa Clara, CA 95054
(408) 654-5820
▶CIRCLE 642

▼ STD 32 ENCLOSURE HOLDS TWO ISA CARDS

Two ISA slots have been added to the 18 or 21 STD 32 slots in the ZT 211 series of enclosures. As a result, STD 32 systems can employ PC I/O cards that aren't available in the STD 32 form factor. Those ISA cards operate transparently within the STD 32 system as if they were STD-based I/O cards. The enclosures also come with removable ac and dc power-supply modules, forced-air cooling, and configurations for table-, wall-, and rack-mounting. The two ISA slots are located at the rear of the card cage in a protected enclosure. The STD backplane supports 8-, 16-, and 32-bit data transfers, while the ISA backplane can handle 8- and 16-bit transfers. The ZT 211 series is designed to withstand the shock and vibration levels associated with industrial environments. Available now, prices start at $1100.



Ziatech Corp.
1050 Southwood Dr.
San Luis Obispo, CA 93401
(805) 541-5088
▶CIRCLE 643

▼ PCMCIA DRIVE HAS 340 MBYTES COMPRESSED

As the availability of PCMCIA slots increases, the demand for peripherals to fill those slots also is growing. Mass storage is one area in particular where advances are coming. For example, the More MB drive holds 171 Mbytes of data in a Type III form factor. With compression, which comes bundled with the drive, the capacity jumps to 340 Mbytes. Users have the option of disabling the Stacker Anywhere compression software. With a proprietary shock-sensor technology, the drive can withstand 200 G of shock during operation and 900 G of non-operating shock. Within its protective case, which is used when the drive is carried external to the system, it can withstand 1200 G. In addition, because the drive is sealed and filled with nitrogen, it's not susceptible to problems when used in harsh environments or at high altitudes. Available now, the More MB drive sells for $599.

MiniStor Peripherals Corp.
2801 Orchard Pkwy.
San Jose, CA 95134
(408) 943-0165
▶CIRCLE 644

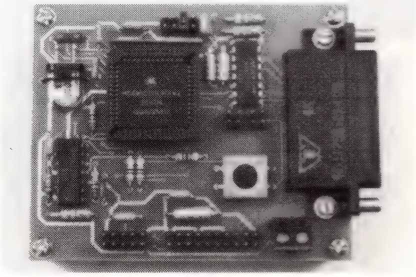
▼ COLOR LASER PRINTER OFFERS HIGH RESOLUTION

Created for networked office workgroups, the 4900 color laser printer is designed with a quad-dot technology that prints up to 1200 by 300 dots/in. It can be connected to either PC or Macintosh networks. The printer is powered by a 25-MHz AMD 29030 RISC CPU with up to 48 Mbytes of RAM. The high resolution eliminates visibly coarse dot structures when reproducing half tones. The printer's engines, manufactured by Hitachi, print 3 pages/min. in full color, 6 pages/min. with two colors, and 12 pages/min. in black and white. The printer can be controlled from the desktop through software. Users can check their job status, download fonts, and check the condition of consumables and maintenance items. It also offers automatic page-description language (PDL) sensing and switching, which eliminates the need for user reconfiguration. PostScript drivers are supplied for Macintosh System 7 Plus, Windows 3.1, and some DOS applications. Available now, the 4900 color laser printer should sell for under $8000.

Xerox Corp.
80 Linden Oaks
Rochester, NY 14625
(706) 264-5715
▶CIRCLE 645

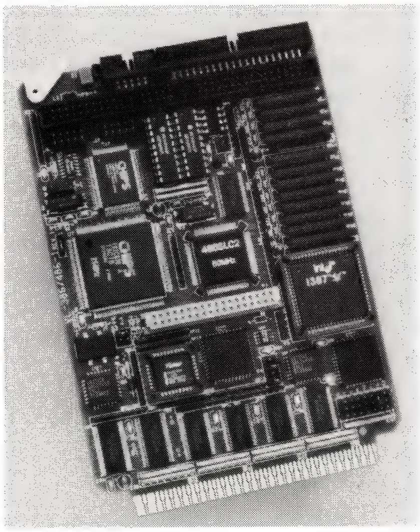
▼ DEVELOPMENT PLATFORMS WORK WITH DSP56166

Two new development products support Motorola's 16-bit digital signal processors—the DS-56166 application-development system and the CC-561xx OnCE command converter. The former is specifically designed for speech-processing applications. The platform-independent system can be controlled by any computer equipped with an RS-232 interface and communicates at speeds up to 38.4 kbits/s. It sells for $695. The CC-561xx converts RS-232 commands from the controlling PC to a format that's compatible with the Motorola OnCE interface for on-chip emulation. As a result, it supplies an emulation capability for prototype products containing a DSP56166. The converter, priced at $335, includes a software development shell that's compatible with most PCs and workstations.



The Accolade Group Ltd.
1695 Sherwood Rd.
Highland Park, IL 60035
(708) 831-3009
▶CIRCLE 646

▼ 50-MHz CPU BOARD FITS STD 32 SPEC



Designed to be compliant with the STD 32 specification, the VL-486-2 CPU board is a DOS-compatible single-board computer. Based on a 50-MHz 486 microprocessor, the board maintains backward compatibility with standard STD 80 boards. It holds up to 4 Mbytes of RAM, and supports 512 kbytes of flash memory or EPROM. I/O is handled through a parallel port, two serial ports, an IDE interface, a floppy-disk interface, and front-panel DMA and interrupt connectors. The VL-486-2 can operate as a part of a multiprocessing system, with direct connection to up to seven other processors. Two development packages are available to help create high-performance control systems. A DOS-based package can be used as both a development and target system, and a non-DOS package can produce ROM-based target systems written in Turbo C or C++. Available now, the VL-486-2 is priced at $1195. Significant discounts apply for quantity purchases.

VersaLogic Corp.
3888 Stewart Rd.
Eugene, OR 97402
(800) 824-3163
▶ CIRCLE 647

▼ QIC TAPE STORES 680 MBYTES COMPRESSED

Using data compression, up to 680 Mbytes of data can be stored on one extended-length cartridge. The Tape510 tape drive, which is based on the QIC 3010 standard, also reads QIC-40, 80, and Irwin formatted cartridges.

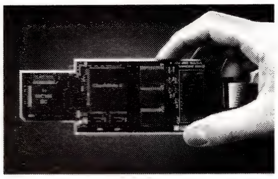
The 1-in. high unit is built with a beltless architecture. By reducing the number of moving components in the drive, it runs cooler, quieter, and more reliably. The magneto-resistive thin-film heads support data-transfer rates up to 9.5 Mbytes/min. Both internal and external models are offered. The external minicartridge drive interfaces with the host platform through the parallel port. Each unit ships with the company's proprietary DOS-based backup software; an OS/2 version also is available. The internal Tape510 is priced at $399, while the external model sells for $599.

Iomega Corp.
1821 W. 4000 S.
Roy, UT 84067
(801) 778-1000
▶ CIRCLE 648

Introducing CheckMate II™

Runs Your Target Fast, So You Make Your Market Window First.

At 25 MHz, the CheckMate II™ emulator is the fastest full-featured system for the 80C186 and 80C188 families. With all the features ever wanted in an emulator, it fits between two fingers. And at $7,000, each design team member can have one – eliminating the emulator as the lab bottleneck.



Whether using Paradigm/DEBUG™ or reducing download time to seconds, the CheckMate II™ emulator is the most efficient. Plus, CheckMate Systems™ offers superior customer support. Be first to your market window. Call us at 206-869-7211 or fax your business card to 206-861-3647.

We Also Support The Intel® 80C196 Family and The NEC® V25.

CheckMate Systems™

CheckMate Systems, P.O. Box 3361, 8581 154th Ave. N.E., Redmond, Washington 98052
Europe: UK 44-0272-860400 Germany 49-08131-25083 France (33)1-3054-2222

READER SERVICE 86

SPOT THE MOST ELUSIVE 80C186 BUGS FAST WITH CODETAP®-XA.

CodeTAP-XA uses Intel® bond-out technology to give you a better view of what's going on inside your '186 processor. So you can find and eliminate bugs faster.

Speed up debugging 80C186-based products with our patented CodeTAP-XA emulator. It takes advantage of Intel-licensed 80C186 bond-out technology to trace code execution in real-time at full speed. You get an accurate picture of what's going on inside the processor, instead of the synthesized signals other emulators provide. Affordably priced and small enough to fit in your shirt pocket, CodeTAP-XA is a full-function emulator designed to solve your most elusive troubleshooting problems. ❧ Paradigm source level debugger is fine-tuned for CodeTAP-XA ❧ Allows complex event triggering ❧ Provides code performance analysis ❧ Includes trace and overlay memory ❧ Toll-free customer support ❧ Call or e-mail us and ask about borrowing a CodeTAP-XA to evaluate, so you can start spotting those hard-to-find bugs in nothing flat.

Also check out our support for Intel's:

80C186/188 XL/EA, EB, EC;
80L186/188 XL/EA, EB, EC; 80286;
80386DX/SX and 80960CA/CF

Applied Microsystems Corporation

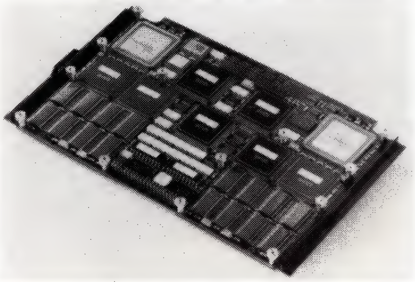
E-mail: info@amc.com

Ask Us How to Get Your Free Evaluation Unit. Call **1-800-426-3925.**

© 1994 Applied Microsystems Corp.

READER SERVICE 203

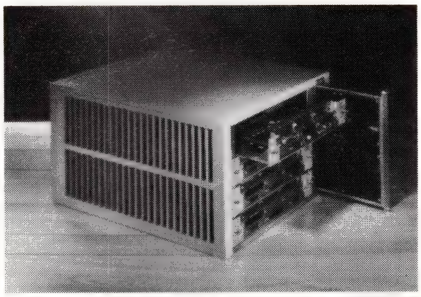
▼ VECTOR SIGNAL PROCESSOR HOLDS i960 AND DUAL i860s



The VSP-1 is a VMEbus vector signal processor for high-performance military, rugged, and commercial off-the-shelf applications. The board employs a modular design that couples dual i860 processors with an i960, plus up to 16 Mbytes of DRAM, to maximize throughput. Consequently, up to 160 MFLOPS of sustained throughput is available in a single-slot form factor. Separate data paths are maintained between memory and the two i860s. A three-by-two matrix ASIC crossbar switch supplies interconnectivity for concurrent high-speed memory access at up to 160 Mbytes/s. The i960 creates a separate processing subsystem with SRAM, flash EPROM, and EEPROM to handle all communications and data transfers over the VMEbus. It also schedules the signal-processing tasks and the dissemination of data to other VSP-1 boards. A 32-bit multiplexed address and data connection can be used to transfer large blocks of raw data from external sensors. In addition, input data can be shared among multiple boards. Support for real-time operating systems is available. Prices for the VSP-1 start at $23,530.

Radstone Technology Corp.
50 Craig Rd.
Montvale, NJ 07645
(800) 368-2738
or (201) 391-2899
▶ CIRCLE 649

▼ EXPANSION CENTER OFFERS 19 SBUS SLOTS



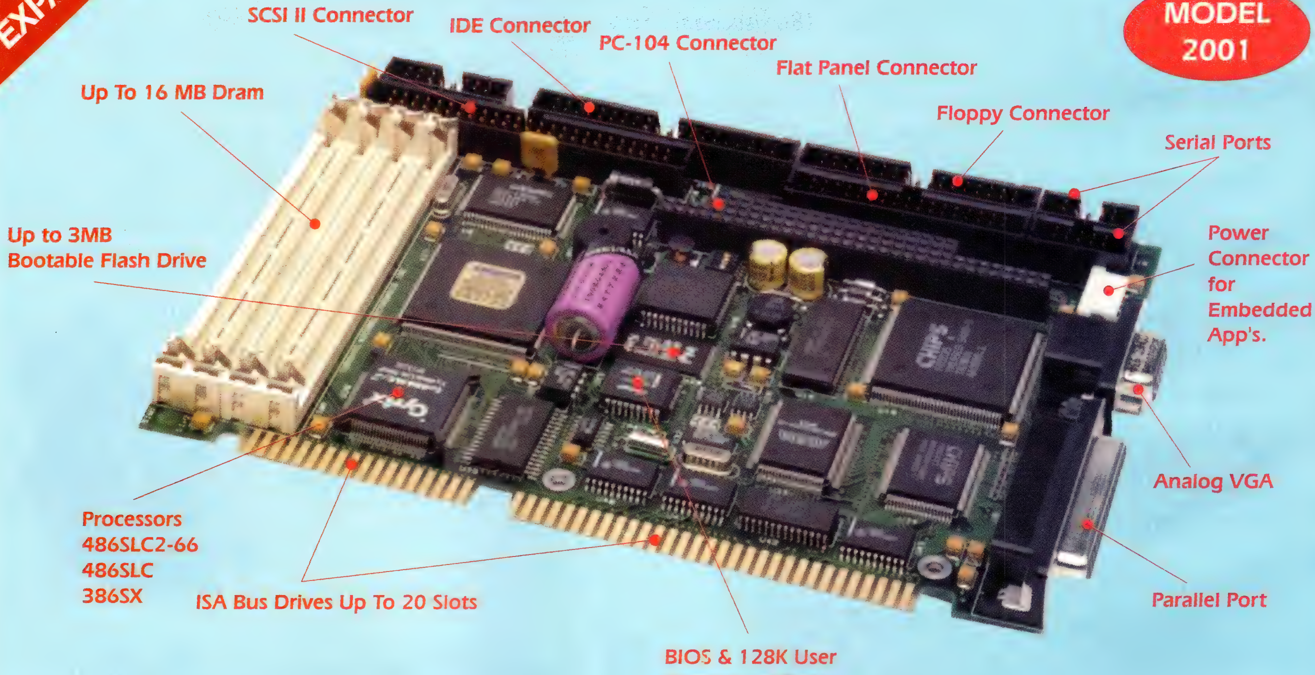
Called an SBus expansion center, the SEC1000 is an enclosure that's configured as a stackable system based on a SuperSparc 10 board, multi-gigabyte RAID drives, and a hot-swappable, redundant, load-sharing power supply. If one power supply fails, another immediately takes over. The 12-by-20-by-12-in. enclosure is suited for I/O-intensive applications such as factory control and automation, in which SBus slots are in demand. It holds one system board and three SBus expansion boards for a total of 19 available SBus slots. Prices start at $9995.

Integrix Inc.
1200 Lawrence Dr., Suite 150
Newbury Park, CA 91320
(800) 300-8288
▶ CIRCLE 650

PC-104 EXPANSION

486 CPU *with* SCSI II *and* FLAT PANEL *interfaces*

MODEL 2001


SCSI II Connector
IDE Connector
PC-104 Connector
Flat Panel Connector
Floppy Connector
Serial Ports
Up To 16 MB Dram
Up to 3MB Bootable Flash Drive
Power Connector for Embedded App's.
Analog VGA
Parallel Port
Processors 486SLC2-66 486SLC 386SX
ISA Bus Drives Up To 20 Slots
BIOS & 128K User Memory in Flash

- 2 Year Warranty.
- Complete line of products available

TME *TORONTO MICROELECTRONICS INC.*
5149 Bradco Blvd, Mississauga, Ontario Canada L4W 2A6
Tel: (905) 625-3203 Fax: (905) 625-3717

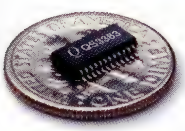
Product names are trademarks or registered trademarks of their respective companies.

READER SERVICE 193

UALITY SEMICONDUCTOR, INC.

Some Delays Can't Be Avoided.

Some Can.



No one likes delays. System engineers especially.

That's why we invented a logic switch so fast it 'disappears' in your system. Its 250 ps propagation delay is *at least* 10 times faster than standard logic devices. So you can say good-bye to logic-induced performance penalties for good.

This high-end technology has swiftly grown into our QuickSwitch® product family. Offering pin-for-pin replacements for bus switches, high-speed buffers and transceivers, and mux/demux devices.

QuickSwitch products deliver delay-free 5V-to-3V signal conversion making them ideal for emerging Pentium-based PCs as well as laptops and PDAs. They also have the hot-plug (live insertion) capability plus a low 5-ohm "On" resistance. They add no power dissipation, no ground bounce, and require no directional control.

QuickSwitch devices come in SOIC, QSOP, and now QVSOP™ as well as standard DIP packages. Call today for the popular *QuickSwitch Product Handbook* chock full of innovative, customer-inspired applications. 1-800-609-3669. Or Fax 408/496-0773.

Avoid delay. We did.

Quality Semiconductor, Inc.

QuickSwitch is a registered trademark of Quality Semiconductor, Inc. Q and QVSOP are trademarks of Quality Semiconductor, Inc.

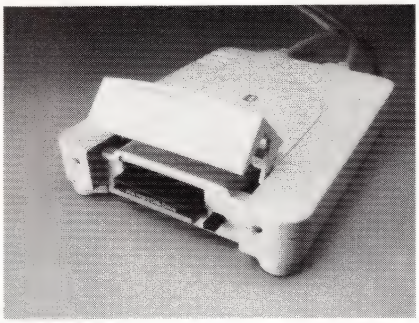
READER SERVICE 234

▼ VIDEO ACCELERATOR CONNECTS TO PCI SLOT

By plugging a graphics add-in board into a PCI slot, performance of that peripheral can be improved. That's the case with the Horizon+PCI GUI accelerator, which is based on the Cirrus Logic GD5430 video controller/accelerator chip. The board integrates an internal digital-to-analog converter with 1 Mbyte of DRAM to realize the high level of performance, but without the high cost. Hence, the Horizon+PCI board is suitable for such applications as multimedia, 3D rendering, games, and presentation packages. Bottlenecks are eliminated because the GUI chip connects directly to the PCI bus. Among the other features are BitBLTs, pattern fills, linear addressing, a hardware cursor, and color expansion. Software drivers are included for Windows, OS/2, Lotus 1-2-3, Microsoft Word, WordPerfect, and AutoCAD. A built-in VESA-compatible feature connector permits the use of other add-in boards, such as video-overlay boards and video-capture boards. The Horizon+PCI card costs $149 and is available immediately.

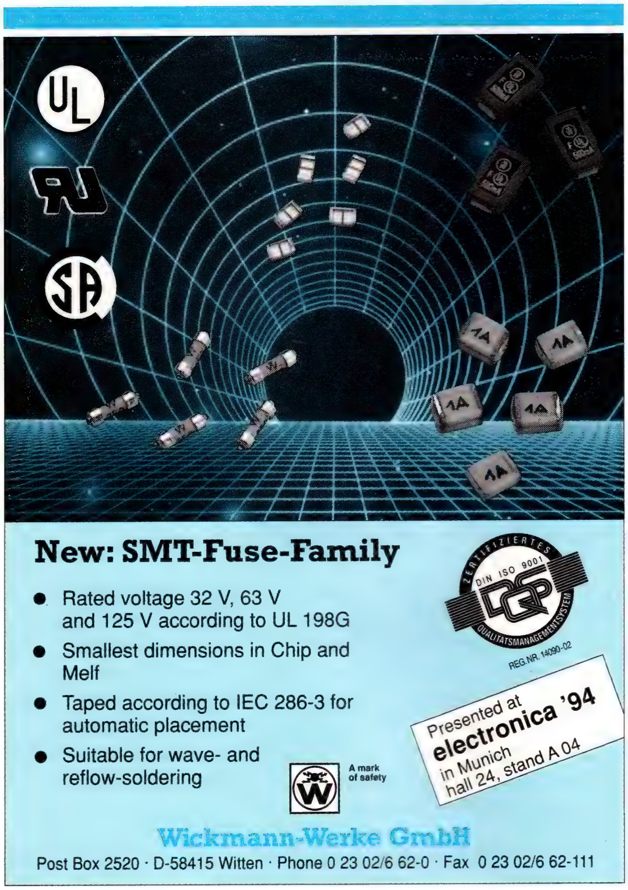
STB Systems Inc.
1651 North Glenville
Richardson, TX 75081
(214) 234-8750
▶CIRCLE 651

▼ PCMCIA CARDS PLUG INTO DESKTOPS



As PCMCIA slots and peripherals become more popular, users are looking for ways to connect those peripherals to their desktop systems. An upgraded internal and external desktop line of PCMCIA card reader/writers is available from Databook Inc. The internal model connects to the ISA bus, while the external unit plugs into the PC's printer port. A pass-through connector lets users plug in a printer in addition to the external drive. The internal model contains one to four Type II slots and can handle any PCMCIA-compatible I/O or mass-storage device. As a result, a Type III card can be plugged in at the same time as a Type II device. The external drive holds one Type I, II, or III card. Both drives come bundled with the company's CardTalk software, which supplies the broad card support and data-transfer compatibility. The software also comes with a user interface that gives access to some advanced features. Both versions of the drive are available now.

Databook Inc.
112 Prospect St.
Ithaca, NY 14850
(607) 277-4817
▶CIRCLE 652



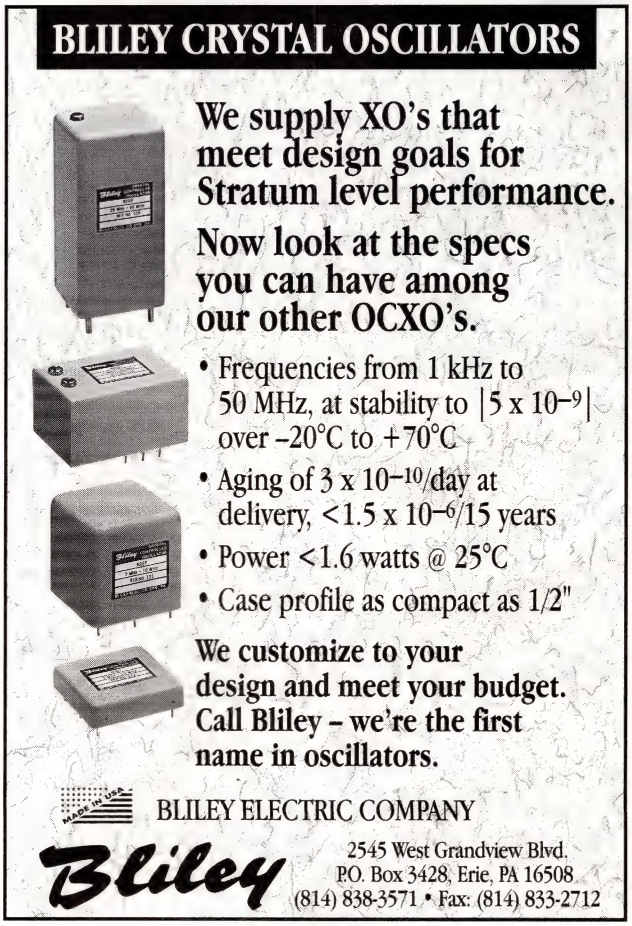
New: SMT-Fuse-Family

- Rated voltage 32 V, 63 V and 125 V according to UL 198G
- Smallest dimensions in Chip and Melf
- Taped according to IEC 286-3 for automatic placement
- Suitable for wave- and reflow-soldering

Presented at electronica '94 in Munich hall 24, stand A 04

Wickmann-Werke GmbH
Post Box 2520 · D-58415 Witten · Phone 0 23 02/6 62-0 · Fax 0 23 02/6 62-111

READER SERVICE 147



BLILEY CRYSTAL OSCILLATORS

We supply XO's that meet design goals for Stratum level performance.

Now look at the specs you can have among our other OCXO's.

- Frequencies from 1 kHz to 50 MHz, at stability to $|5 \times 10^{-9}|$ over –20°C to +70°C
- Aging of 3×10^{-10}/day at delivery, $<1.5 \times 10^{-6}$/15 years
- Power <1.6 watts @ 25°C
- Case profile as compact as 1/2"

We customize to your design and meet your budget. Call Bliley – we're the first name in oscillators.

BLILEY ELECTRIC COMPANY

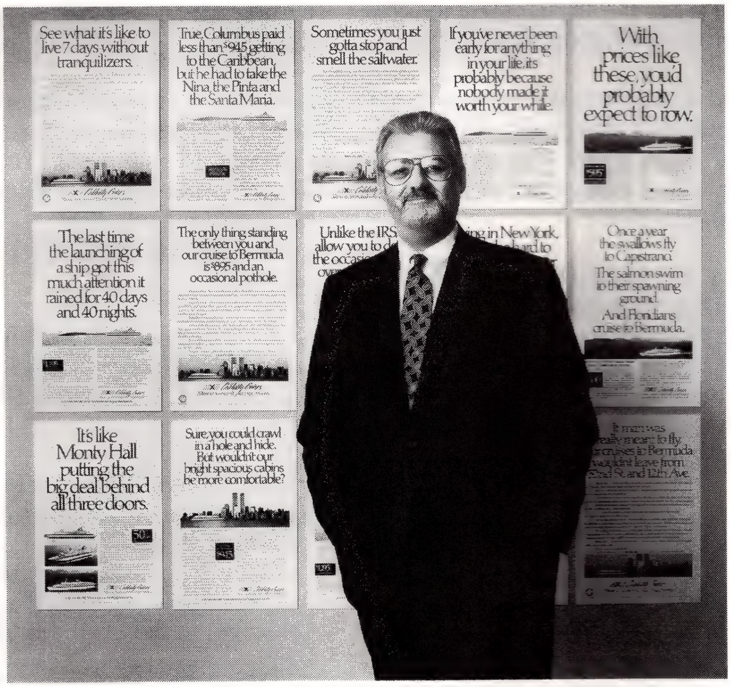
Bliley

2545 West Grandview Blvd.
P.O. Box 3428, Erie, PA 16508
(814) 838-3571 • Fax: (814) 833-2712

READER SERVICE 253

"Increasing our ad budget was so successful, our agency recommended we cut it."

Photo: Frank Moscati



See what it's like to live 7 days without tranquilizers.
True, Columbus paid less than $945 getting to the Caribbean, but he had to take the Nina, the Pinta and the Santa Maria.
Sometimes you just gotta stop and smell the saltwater.
If you've never been early for anything in your life, it's probably because nobody made it worth your while.
With prices like these, you'd probably expect to row.
The last time the launching of a ship got this much attention it rained for 40 days and 40 nights.
The only thing standing between you and our cruise to Bermuda is $895 and an occasional pothole.
Once a year the swallows fly to Capistrano. The salmon swim to their spawning ground. And Floridians cruise to Bermuda.
It's like Monty Hall putting the big deal behind all three doors.
Sure, you could crawl in a hole and hide. But wouldn't our bright spacious cabins be more comfortable?

Al Wallack, Sr. VP Marketing, Celebrity Cruises, after returning from having his hearing checked.

"A great time to introduce a new luxury cruise line. The economy was in a slump, and the competition was on the rise.

We told our new advertising agency we have to go in with all guns blazing. And gave them the extra money to do it.

They recommended a three phase campaign. Phase 1. Full page newspaper. One ad a week for 24 weeks and one-third pages in the travel section. Phase 2, radio. Then 3, television to sweep up one season and sow the seeds for the next.

To make a long story short, two-thirds into the newspaper phase, Celebrity's ships were just about full to the end of the season. With so little left to sell, we all agreed to hold the radio and TV and save the remainder of the budget.

In roughly two years Celebrity became the number one cruise line from New York to Bermuda.

We've just added another new luxury ship and we're anxious to fill it. So once again we've upped our budget. So far, our agency hasn't tried to talk us out of it."

AAAA

American Association of Advertising Agencies

If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, NY 10017 enclosing a check for five dollars. You will receive our booklet, *It Works! How Investment Spending In Advertising Pays Off.* Please allow 4 to 6 weeks for delivery.

This advertisement prepared by Korey, Kay & Partners, New York.

FREE ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:

- Telecommunications
- Semiconductors
- Computers
- International Trade

☐ YES! Send me my FREE issue of *ELECTRONICS* and enter my 1-year subscription, 23 issues—for 10% off the regular subscription rate! If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates:
(U.S. funds drawn from a U.S. bank)

☐ U.S. ~~$98~~ $88
☐ Canada ~~$120~~ $108 (plus GST)
☐ Other Countries ~~$190~~ $171

Please bill my credit card:
☐ Visa ☐ MasterCard
☐ AMX ☐ Discover

Card No. __________
Exp. Date __________
Signature __________
Date __________
Name __________
Title __________
Company __________
Mailing Address __________

Order by FAX: 216/696-6413
or call 216/696-7000, x 4137

UPCOMING MEETINGS

OCTOBER

1st International Conference on Flex Circuits (FLEXCON '94), Oct. 12-14. Sunnyvale Hilton, Sunnyvale, CA. Contact Subash Khadpe at (610) 799-0419; fax (610) 799-0519.

Singapore Informatics '94, Oct. 13-16. Singapore World Trade Center, Singapore. Contact Ellen Wong, Commerce Tours International, Inc., 870 Market St., Suite 920, San Francisco, CA 94102; (415) 433-3072; fax (415) 433-2820.

2nd ACM International Conference on Multimedia (ACM Multimedia '94), Oct. 15-20. Hyatt at Embarcadero, San Francisco, CA. Contact John Limb, Hewlett-Packard Co., 1501 Page Mill Rd., M/S IU-19, Palo Alto, CA 94304; (415) 857-2255; E-mail: jol@hpl.hp.com.

1994 GaAs RED Workshop, Oct. 16. Wyndam Franklin Hotel, Philadelphia, PA. Contact William J. Roesch, TriQuint Semiconductor, (503) 644-3535, ext. 273.

1994 Wireless Circuits, Interconnection, and Assembly Workshop, Oct. 16-19. Paradise Valley, AZ. Contact Sharon Aspden, conference coordinator, Rogers Corp., 100 S. Roosevelt Ave., Chandler, AZ 85226; (602) 961-1382; fax (602) 961-4533.

1994 IEEE GaAs IC Symposium, Oct. 16-19. Wyndham Franklin Plaza Hotel, Philadelphia, PA. Contact Donald C. D'Avanzo, Hewlett-Packard Co., 1412 Fountaingrove Pkwy., Santa Rosa, CA 95403; (707) 577-2644; fax (707) 577-2036.

1994 1st International Conference on Materials for Microelectronics, Oct. 17-19. Hotel Feria Palace, Barcelona, Spain. Contact Juliet A. Upton, The Institute of Materials, Conference Dept., 1 Carlton House Terrace, London SW1Y 50B, United Kingdom; (44)-71-235-1391; fax (44)-71-823-1632.

1994 International Conference on Neural Information Processing (ICONIP '94), Oct. 17-20. The Swiss Grand Hotel, Seoul, Korea. Contact ICONIP '94 - Seoul Secretariat, c/o INTERCOM Convention Services Inc., SL Kang Nam, P.O. Box 641, Seoul 135-606, Korea; (82)-2-515-1560; fax (82)-2-516-4807.

5th International Conference on Signal Processing Applications & Technology, featuring DSP World Expo (ICSPAT '94), Oct. 18-21. INFOMART Conference and Exhibition Center, Dallas, TX. Contact Cynthia Margulis, DSP Associates, 49 River St., Waltham, MA 02154; (617) 891-6000; fax (617) 899-4449.

1994 International Conference on Power System Technology, Oct. 18-21. Beijing Continental Grand Hotel, Beijing, China. Contact Prof. P.Y. Wang, Electric Power Research Institute, Quinghe, Beijing 100085, China; (86)-1-2913201; fax (86)-1-2913126.

Soft Ferrite Users Conference '94, Oct. 24-25. Westin O'Hare Hotel in Chicago (Rosemont) IL. Contact Magnetic Materials Producers Association, 11 S. LaSalle St. #400, Chicago, IL 60603; (312) 201-0101; fax (312) 201-0214.

Geoworks Technology Summit '94, Oct. 25-26. The Hyatt Regency, Burlingame, CA. Call (800) 524-1857, ext. 1212.

Plastic Optical Fiber Technology & Applications Conference (POF '94), Oct. 26-28. Yokohama, Japan. Contact Information Gatekeepers Inc., 214 Harvard Ave., Boston, MA 02134; (617) 232-3111; fax (617) 734-8562.

1994 IEEE Nuclear Science Symposium (NSS), Oct. 30-Nov. 5. Norfolk, VA. Contact Lowell A. Klaisner, Stanford Linear Accelerator Center (SLAC), P.O. Box 4349, Mail Stop 30, Stanford, CA 94309; (415) 926-4463; fax (415) 926-3654.

18th Space Simulation Conference, Oct. 31-Nov. 3. Hyatt Regency Hotel, Baltimore, MD. Contact Julie Kendrick, The Institute of Environmental Sciences, 940 E. Northwest Hwy., Mount Prospect, IL 60056; (708) 255-1561; fax (708) 255-1699.

Our chip caps fit in a pager so small, it comes clipped to a 4-inch belt.

These days, when design engineers think big, they're usually thinking *small*. So they need highly miniaturized components like Murata 0402 ceramic chip capacitors. Murata has led the world in setting standards for quality and miniaturization in chip capacitors. So it should be no surprise that the world's largest manufacturer of ceramic capacitors introduced the smallest size currently available, the 0402. Our array of capacitors includes monolithic ceramic capacitors, microwave capacitors, ceramic disc capacitors and variable capacitors. And whether your design includes high voltage or high frequency applications, or requires superior performance and stability under high temperatures, you should depend on the quality of Murata capacitors. Especially when you're designing a product to go on the wrist, instead of the waist. For more information, call **1-800-831-9172, ext. 149.**

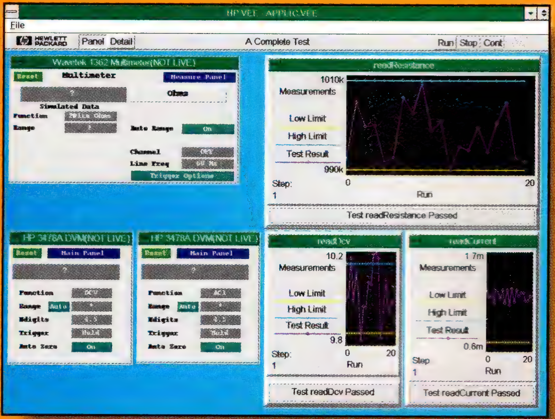
muRata®

A small part
in your success

©1994 Murata Electronics North America, Inc., 2200 Lake Park Drive, Smyrna, GA 30080. All rights reserved.

READER SERVICE 177

You need to
cont
every test instrument.
So why in
the w
would you consider a te
language that can't?



A Complete Test

Wavetek 1362 Multimeter(NOT LIVE)

Multimeter

Ohms

Simulated Data

Auto Range On

readResistance

1010k Measurements

990k

Step: 1

Test readResistance Passed

HP 3478A DVM(NOT LIVE)

Auto Zero On

readDcv

10.2 Measurements

9.8

Step: 1

Test readDcv Passed

readCurrent

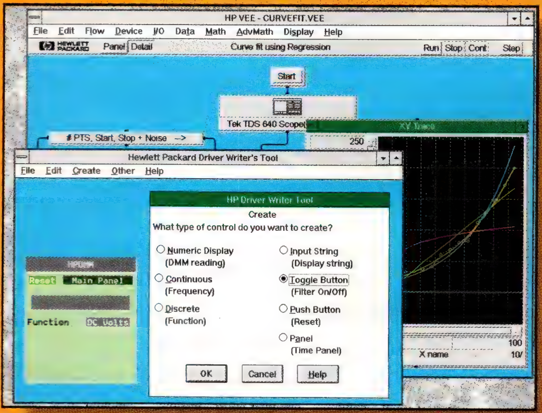
1.7m Measurements

0.6m

Step 1

Test readCurrent Passed

HP VEE makes it easy to create a user interface that allows your test operator to view and change settings.



Curve fit using Regression

Function DC Volts

HP Driver Writer Tool

Create

What type of control do you want to create?

○ Numeric Display (DMM reading)
○ Continuous (Frequency)
○ Discrete (Function)
○ Input String (Display string)
● Toggle Button (Filter On/Off)
○ Push Button (Reset)
○ Panel (Time Panel)

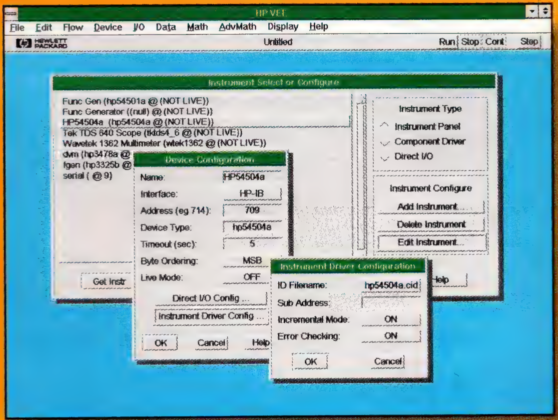
Custom drivers with instrument control panels can be created in minutes using the built-in driver writer tool.

©1994 Hewlett-Packard Co. TMVXD406/INTL Microsoft Windows is a U.S. trademark of Microsoft Corporation.

rol

rld

rogramming



Func Gen (hp54501a @ (NOT LIVE))
Func Generator ((null) @ (NOT LIVE))
HP54504a (hp54504a @ (NOT LIVE))
Tek TDS 640 Scope (tktds4_6 @ (NOT LIVE))
Wavetek 1362 Multimeter (wtek1362 @ (NOT LIVE))
dvm (hp3478a @
fgen (hp3325b @
serial (@ 9)

Name: HP54504a
Interface: HP-IB
Address (eg 714): 709
Device Type: hp54504a
Timeout (sec): 5
Byte Ordering: MSB
Live Mode: OFF

ID Filename: hp54504a.cid
Sub Address:
Incremental Mode: ON
Error Checking: ON

Control any instrument by using HP VEE's direct I/O feature.

Get control of test development.

Use the wrong graphical programming language, and you'll discover something shocking. It's not easy to control every test instrument.

Use the *right* GPL and every device in your lab — from the most oddball black box to the most common test instrument — is easily controllable.

Which *is* the right GPL? HP VEE — our visual engineering environment — the GPL designed specifically for test engineering.

Get control of all your instruments.

The last thing you want to discover is that you can't control a certain instrument. With HP VEE, that won't be a concern.

HP VEE was designed for test. So it supports multiple interfaces, including IEEE 488, RS-232, PC plug-ins, with VXI control built right in.

You also get a variety of ways to address your instruments: direct I/O, hundreds of supplied drivers, and a remarkably simple driver writer tool. All of which let you control test instruments (and all of their functions) from virtually every vendor.

Get control of your existing code.

You've spent years laboring over the code you've written. Unfortunately, most GPLs ask you to throw it away.

HP VEE, on the other hand, provides standard ties to standard languages to let you leverage existing code. And while we're on the subject of open systems, HP VEE runs on Windows, HP-UX, Sun workstations and embedded VXI controllers, with the programs you create portable between platforms.

See what we mean? If you can control your impulse to buy just any graphical programming language, you can control the world.

To get a free preview disk and more, call your local HP sales office or one of the numbers listed below.

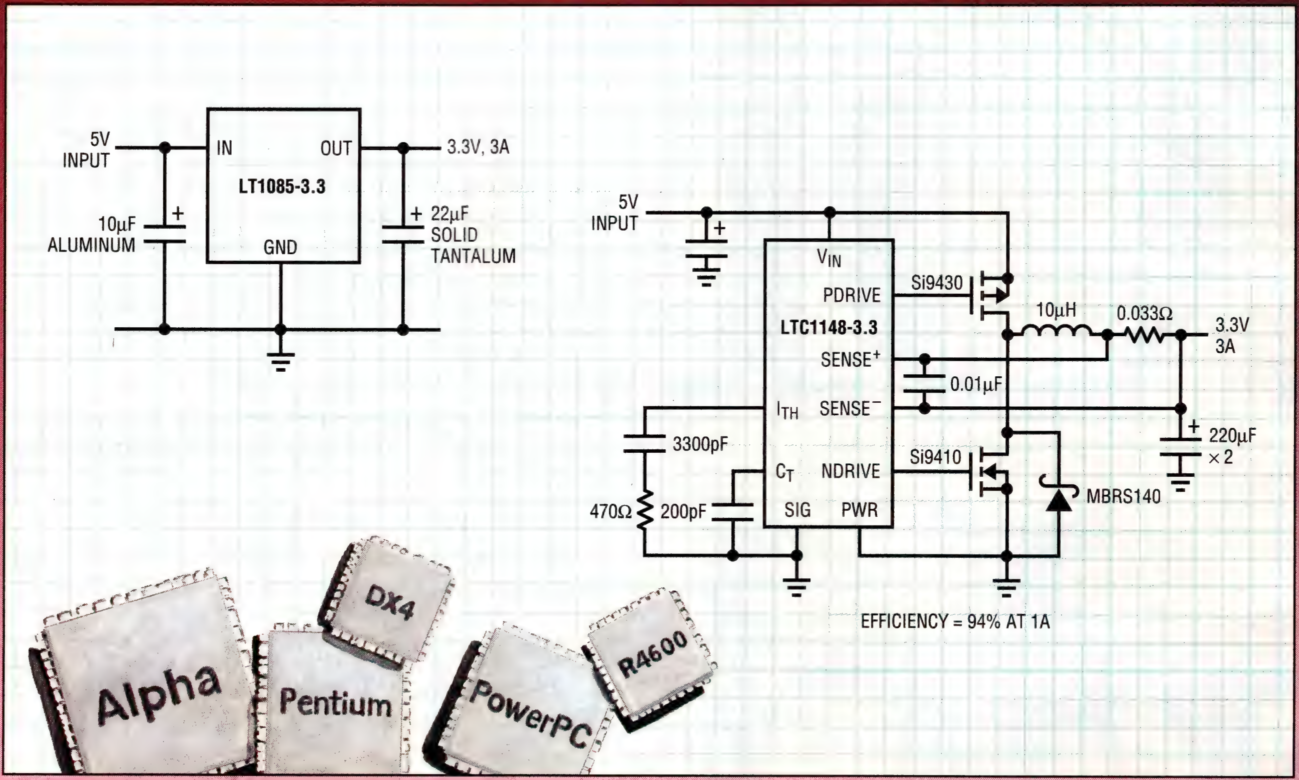
Australia (008) 033-821 • Austria (0660) 8004 • Belgium (02) 778-3417 • France (1) 69-82-60-20 • Germany (07031) 14-6333 • Hong Kong (852) 848-7070 • India (11) 463-2379 • Ireland (01) 2844-633 • Italy (02) 92-122-241 • Korea (2) 769-0800 • Netherlands (020) 547-6222 • PRC (1) 505-3888 • Singapore 291-8554 • Spain (91) 631-15-02 • Sweden (08) 750-2277 • Switzerland 01/735-72-00 • Taiwan (2) 717-9524 • United Kingdom (0344) 366666

There is a better way.

HEWLETT® PACKARD

READER SERVICE 160

5V→3.3V: Linear or Switcher?



You have chosen your processor, now you must choose your power supply. Linear Technology provides you with the best solutions, linear regulator or switching regulator to convert from 5V to 3.3V at any current. We also allow you to tailor your output from 2.9V to 3.6V.

For highest efficiency, the LTC1148 synchronous switching regulator will convert from 5V to 3.3V at up to 10A loads with greater than 90% efficiency. Linear Technology also provides synchronous switching designs for high efficiency at currents up to 20A at 3.3V! These solutions require no heat sinks, allowing easy integration onto your CPU board.

For lowest cost, the LT1085 low dropout linear regulator provides up to 3A of load current at a regulated 3.3V in standard TO-220 or power surface mount DD packages. Linear Technology's broad line of low dropout linear regulators supply up to 7.5A for 5V to 3.3V conversion applications. LTC also has micropower linear regulators for low current, battery powered applications requiring the lowest quiescent current.

Output Current	Linear Regulator	Switching Regulator
1.5A	LT1086-3.3	LTC1147-3.3
3A	LT1085-3.3	LTC1148-3.3
5A	LT1084-3.3	LTC1148-3.3
7.5A	LT1083	LTC1148-3.3
10A	LT1087 (X2)	LT1158
15A (20A Peak)	N/A	LT1158

Linear Technology has the parts, designs and applications assistance to make your source for 3.3V power design an easy choice. For details, contact Linear Technology Corporation, 1630 McCarthy Boulevard, Milpitas, California 95035/ 408-432-1900. For literature only, call **1-800-4-LINEAR**.

LINEAR TECHNOLOGY

FROM YOUR MIND TO YOUR MARKET
AND EVERYTHING IN BETWEEN.

READER SERVICE 101

Alpha is a trademark of Digital Equipment Corporation.
Pentium & DX4 are trademarks of Intel Corporation.
PowerPC is a trademark of IBM.

UPCOMING MEETINGS

OCTOBER

1994 IEEE International Conference on Computer Design: VLSI in Computers & Processors (ICCD), Oct. 10-12. Royal Sonesta Hotel, Cambridge, MA. Contact IEEE Computer Society, Volunteer Services Dept., 1730 Massachusetts Ave. N.W., Washington D.C. 20036-1903; (202) 371-1013.

1994 Symposium on Low Power Electronics, Oct. 10-12. The Doubletree Hotel at Horton Place, San Diego, CA. Contact Diane Suiters, 655 15th St. NW, Suite 300, Washington, DC 20005; (202) 639-4255; fax (202) 347-6109.

1994 International Display Research Conference, Oct. 10-13. Hyatt Regency Hotel, Monterey, CA. Contact Ralph Nadell, Palisades Institute for Research Services Inc., 201 Varick St., New York, NY 10014; (212) 620-3341.

1994 1st European Workshop on Mobile/Personal SATCOMS (EMPS '94), Oct. 11-12. ESA/ESRIN, Rome, Italy. Contact Prof. Francesco Vatalaro, Dipartimento Di Ingegneria, Elettronica, Universita Di Roma Tor Vergata, Via della Riccerca Scientifica 00133 Rome, Italy; (39)-6-72594464; fax (39)-6-72594454.

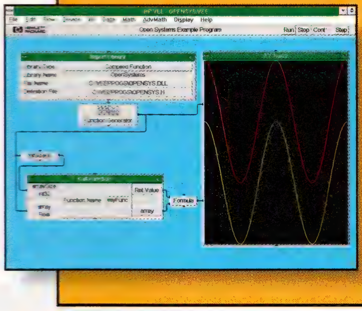
1994 3rd International Conference on Intelligence in Networks (ICIN '94), Oct. 11-13. Bordeaux - Palais des Congres, Bordeaux, France. Contact Jean Rivenc, ADERA, BP 196, 33608 Pessac Cedex, France; (33)-56-15-11-56; fax (33)-56-15-11-60.

NORTHCON '94, Oct. 11-13. Washington State Convention Center, Seattle, WA. Contact J. Carlisle, Electronic Conventions Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045; (310) 215-3976; fax (310) 641-5117.

15th Aerospace Testing Seminar, Oct. 11-13. Radisson Plaza Hotel, Los Angeles, CA. Contact Julie Kendrick, The Institute of Environmental Sciences, 940 E. Northwest Hwy., Mount Prospect, IL 60056; (708) 255-1561; fax (708) 255-1699.

It seems like **half** your life is spent developing test programs. But then, that's **the cost** of using the wrong programming language.

© 1994 Hewlett-Packard Co. TMVXD440/INTL



With HP VEE 50% off, the transition to graphical programming is even easier.

Imagine, today's most powerful, intuitive GPL for half-price — a price that's comparable to text-based languages.

But hurry. This offer expires on December 31, 1994. Order before then and we'll include a free 6-month support contract for software updates, including our next upgrade.

To take advantage of our half-price savings offer, call your local HP sales office or one of the numbers listed below.

Australia (008) 033-821 • Austria (0660) 8004 • Belgium (02) 778-3417 • France (1) 69-82-60-20 • Germany (07031) 14-6333 • Hong Kong (852) 599-7070 • India (11) 463-2379 • Ireland (01) 2844-633 • Italy (02) 92-122-241 • Korea (2) 769-0800 • Netherlands (020) 547-6222 • PRC (1) 505-3888 • Singapore 291-8554 • Spain (91) 631-15-02 • Sweden (08) 750-2277 • Switzerland 01/735-72-00 • Taiwan (2) 717-9524 • United Kingdom (0344) 366666

There is a better way.

HEWLETT® PACKARD

READER SERVICE 92

BASE CELL DESIGN SPAWNS ADVANCED ARRAYS

FOURTH-GENERATION CMOS ARCHITECTURE OFFERS INCREASED DENSITY AND HIGHER ROUTING EFFICIENCIES.

CHERYL AJLUNI

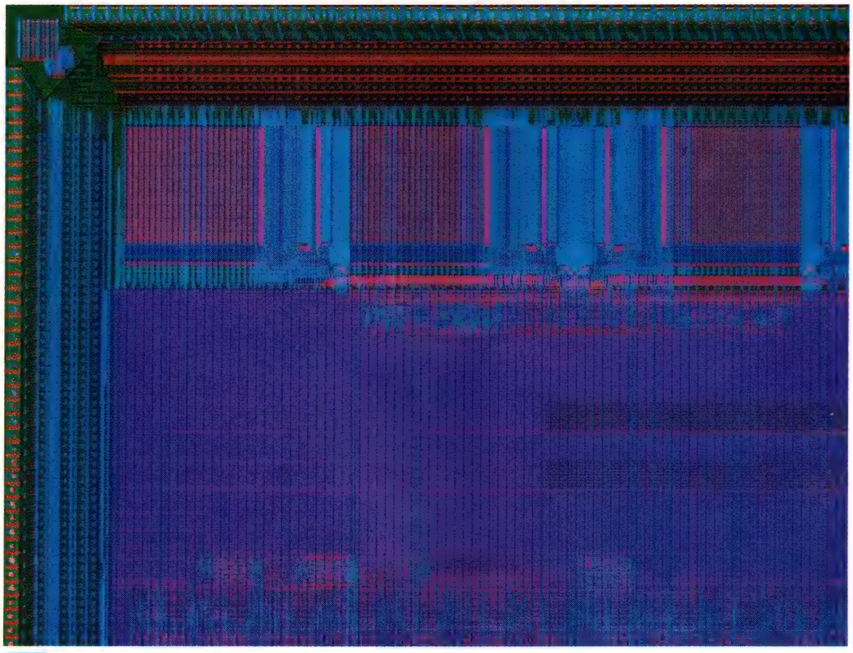
Conventional gate-array cells based on 0.5-µm technology generally are just a shrink of a previous cell design. Such cells do achieve fairly high densities, but they don't bring any new features to new applications. Designers therefore are forced to either eliminate some of the complexity in their designs and forego any extra application features, or use arrays containing many more transistors than are actually needed to squeeze required functions onto the chip.

Due to wiring limitations on today's arrays, most gate-array vendors quote a gate-utilization percentage of 40 to 60% (depending on the design) for 0.5-µm arrays using three levels of metal interconnects. That means only about half the chip's transistors (according to Motorola) are actually put to work, with the remainder forced to remain idle. As a result, the cost of the silicon is much higher than necessary due to the inefficient utilization.

However, by improving the array architecture, designers at the ASIC division of Motorola developed a family of CMOS gate arrays, the M5C series, that delivers denser layouts and higher routing efficiency. The key is a new area-efficient core cell and a stacked-via, planarized multilevel metal interconnection scheme. The arrays in the family push cell utilization past 70% and allow smaller, and thus lower-cost, chips to deliver the functionality of larger, previous-generation arrays *(Fig. 1)*.

The architecture centers around an innovative base cell optimized to approach the performance of standard cells on the critical cell types found in today's complex ASICs, which include multiplexers, latches, flip-flops and dedicated memory blocks. The basic cell consists of 20 transistors: 12 p-type; 4 large, high-drive, n-type; and 4 small, low-drive n-type transistors. The low-drive devices work well for multiplexers, flip-flops, and other internal functions, while the high-drive types are best suited for cross-chip driving. With a symmetrical internal cell architecture, the base cells can be mirrored, providing an added feature of simplicity of array layout.

The devices employ a self-aligned, twin-tub, 0.5-µm process in which n- and p-type well implants are applied simultaneously to form deep, balanced wells that improve the performance of short n-channel transistors. A lightly-doped drain diffusion reduces the hot-carrier injection effects caused by a high electric field in the short-channel transistors. The resulting performance yields typical gate delays for a two-input NAND cell of just 240 ps when operated at 3.3 V and



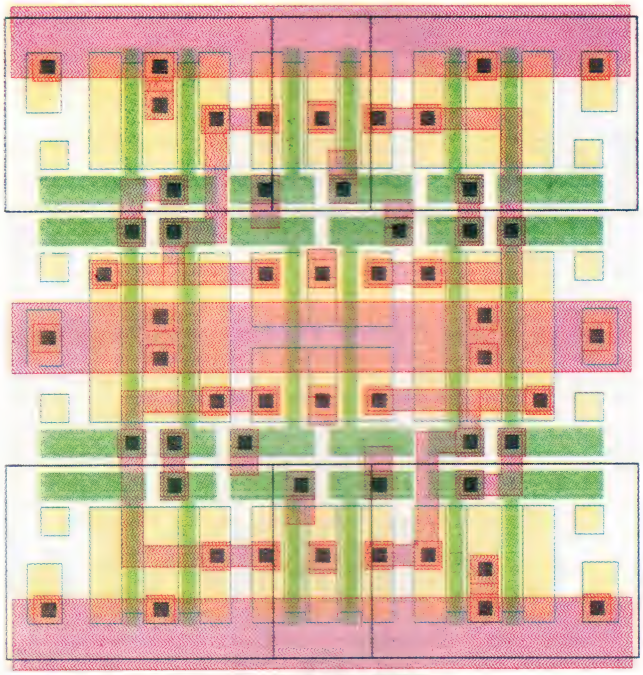
1. ONE CORNER of this die depicts one of three analog phase-locked loops and embedded RAM found on the basic cell of Motorola's M5C CMOS arrays.

loaded with a fan-out of 2. Power consumption is about 1 µW/gate/MHz, also when powered by a 3.3-V supply.

The M5C gate-array process is the same one used for Motorola's advanced CPUs, the 68060 and the low-power 68040. It integrates advanced features such as filled tungsten plugs, stacked vias and contacts, planarized metallization, an epitaxial silicon layer, and silicided gates, sources, and drains. Making use of the stacked vias and contacts, a triple-level-metal (TLM) interconnection structure delivers much higher routability than in previous three-level-metal schemes that didn't use the stacked vias and contacts. The improved routability also eases power and clock distribution and helps reduce signal delays previously attributed to very long interconnections.

The base cell can implement a D-type flip-flop and a two-bit dual-port RAM in less area than is possible with 0.5-µm shrinks of previous-generation base-cell designs—20% and 50%, respectively—and with no second-layer metal strap *(Fig. 2)*. This size reduction results primarily from the use of stacked vias and contacts, the two sizes of NMOS transistors, and an increased number of grid intersections per primary cell. Routability also is improved. Capitalizing on the stacked-vias feature also all but eliminates common blockage problems. The cells thus offer increased density without any major changes in tools, and allow for significantly more complex designs in smaller areas.

With an increased density and routability per unit area, a typical 460-kgate device, for example, would have an estimated utilization of roughly 65 to 75%. Previous generations of the same die size possess only about a 55% utilization. Thus more complex designs can go on the same size chip, and more complex functions_datapaths and other bus-oriented structures, will run more efficiently at 15% faster than a similar 0.5-µm shrink.



2. THIS BASIC CELL OF THE Motorola M5C CMOS arrays is configured as two bits of dual-port RAM. The device takes up one-half the area that would be required for a previous generation array when shrunk to 0.5-µm design rules, and operates at a 15% faster rate.

The M5C family will offer base arrays (masterslices) with raw gate counts of 42 to 800 kgates. The arrays can operate at low voltage levels, or in mixed-voltage (3.3 and 5 V, for example) systems. Moreover, the array core can run at even lower voltages—2.5 or 1.8 V. Designers thus can customize the arrays to particular power and performance needs. The arrays feature true 3.3- and 5-V I/O capability, and a high-speed interface. Analog phase-locked loops (PLLs), one embedded in each of three die corners, also are included to provide stable clock signals at up to 175 MHz. Also, the base cell contains eight P/N antenna diodes. They provide ESD protection for the gate oxide during processing by creating a leakage path for the charge accumulated during the metal plasma etch. They also protect each base-cell port (defined by the megacell I/Os). The result is better long-term reliability, higher manufacturing yield, and built-in ESD protection.

While a novel feature for any 0.5-µm device, adding diodes becomes critical as geometries get even smaller. A 0.35-µm device, for example, can be extremely fragile to work with in the processing stages. Generally speaking, the extra boost in yield provided by the antenna diodes makes geometries of less than a 0.5 µm feasible.

The M5C series has a strong I/O offering, complete with full-function I/O cells with embedded JTAG capability and low-voltage differential signaling (LVDS). Among other applications, LVDS lets the arrays directly comply with standard pseudo-ECL voltage inputs; peripheral component interconnect (PCI) and GTL interfaces; and the interface needs of the scalable coherent interface standard, operating at up to 600 MHz. The I/O type is selectable on a site-by-site basis.

The structure, a next-generation version of the H4CP I/O cell, also has a significantly improved slew-rate control function. Whereas old slew rates were adjustable over 10 to 15% and 20 to 30% ranges, the improved slew rate can be adjusted by 80 to 150%, for increased system flexibility.

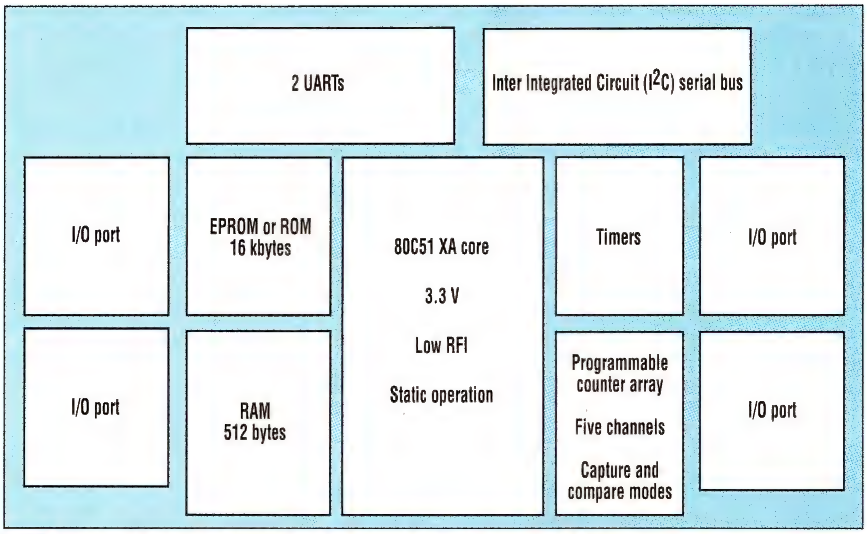
The array family can have up to 352 I/O pads and up to 432 I/O cells, allowing for a number of wirebond and mounting schemes. Packaging options include the company's high-density, overmolded, pad-array carrier (OMPAC) ball-grid array (169 to 313 contacts), the MicroCool high-heat-dissipation PQFP with an integral heat slug (160 and 208 leads), and standard QFPs (128 to 240 leads).

PRICE AND AVAILABILITY

The first M5C series product offerings, in a number of planned releases, are currently available with gate counts ranging from 112 to 460 kgates. Future releases will feature larger arrays with up to 800 kgates. The nonrecurring engineering charges for a chip with 125,000 used gates is about $160,000, and when housed in a 225-lead OMPAC or a 240-lead QFP, the chip sells for about $65 each in lots of 5000 to 10,000 units.

Motorola Inc., Application Specific Integrated Circuits Division, 1300 N. Alma School Rd., Chandler, AZ, 85224; Frank Reid (602) 814-4047. **CIRCLE 512**

HOW VALUABLE?	CIRCLE
HIGHLY	528
MODERATELY	529
SLIGHTLY	530



THE 16-BIT 80C51 XA MICROCONTROLLER integrates 16 kbytes of ROM or EPROM, and can access up to 16 Mbytes externally. The device's special-function register permits the UARTs, timers, and an I^2C bus to interface directly with the XA core.

ENHANCED MICROCONTROLLER ARCHITECTURE MAINTAINS BACKWARD COMPATIBILITY WHILE DRASTICALLY IMPROVING PERFORMANCE.

80C51 MICROCONTROLLER JUMPS TO 16 BITS

RICHARD NASS

The 8-bit 8051, one of the most popular microcontrollers in the industry, is now 13 years old, and characteristic of many teenagers, is expected to experience a quick surge in growth. A 16-bit derivative that operates at 3.3 V soon will be available, offering higher performance, lower voltage operation, reduced RFI, static operation, an extended address range, and an enhanced instruction set.

The original 8051 and its later variations are used in a broad spectrum of applications, from toys to disk drives to consumer electronics. However, many other potential applications loom at the upper end of the 8-bit market, where even the present higher performance 8-bit units may have difficulty meeting the required performance goals. Now, with the introduction of the 30-MHz, 16-bit derivative—the 80C51 XA from Philips Semiconductors, Sunnyvale, Calif.—the range of applications will be extended.

In the Philips device, particular attention was paid to power and noise generation. The ability to operate at 3.3 V means the part consumes less power. A further power savings is derived from the device's ability to operate in a static mode, which permits the power draw to be reduced by slowing down or even stopping the clock. In many 80C51s, if the clock is stopped, the information that resides in the internal nodes will be lost.

The higher-performance 8-bit components, such as the 40-MHz part, generate significant amounts of noise. However, the 80C51 XA's lower clock speed helps diminish the RFI produced by the chip. "In so many applications, the radiated noise is becoming a problem for our customers," says Mike Thompson, product marketing manager at Philips. "Any design that we do today, we keep a close watch on the noise that's radiated from the part, including internal signals."

Another source of noise lies in the address-latch enable (ALE), an external signal that latches an address into an external memory device. Typically, the ALE is kept running, whether or not external memory is employed, causing increased RFI. However, the 80C51 XA can disable the ALE, which helps reduce the RFI when external memory isn't used. The clock drivers and internal buffers also are optimized to generate as little noise as possible while still meeting the speed requirements.

Because the 80C51 XA is a 16-bit microcontroller, it requires fewer clock cycles per instruction than an 8-bit part. The 8-bit 80C51 demands 12 clocks/instruction, while the XA version needs just three. This results in a higher performance level at a lower clock speed.

The 80C51 XA is a register-based part, unlike traditional accumulator-based microcontrollers. It has 16 internal byte registers that handle all of the operations. Consequently, the number of moves required to get data in and out of memory are reduced. Also incorporated are two internal stacks, a supervisory stack, and an applications stack. This means that two operations can run simultaneously, resulting in a real-time multitasking capability. The stack pointer can be located anywhere in the data memory space, or, in other words, anywhere in the internal or external memory. The entire stack-pointer space is contiguous, starting at zero and ending up somewhere off-chip, determined by the amount of external memory employed.

The 80C51 XA is backward-compatible with existing 80C51 code. That's important because there's a large installed base of third-party support for the 80C51 already in place, as well as a large user-knowledge base for the 80C51. Because the mnemonics have remained the same, users could run their 8-bit code directly on the 16-bit XA platform. It need only be translated, because some minor details aren't exactly the same and adjustments would be required for any speed differences.

The Philips designers also added about 30% more instructions to the chip's instruction set to make it more usable with high-level languages. Along with the increase in instructions are enhancements to many of the existing instructions to take advantage of the 16-bit architecture.

The part will be available initially with 16 kbytes of EPROM and 512 bytes of RAM. "Customers are always demanding more memory," says Thompson. "In five years, we'll probably be designing a microcontroller with 1 Mbyte of memory."

The next generation will offer flash memory or a mixture of flash and EPROM. Flash offers in-circuit reprogrammability, because some users may want to reprogram the chip in the field.

The 80C51 XA addresses up to 16 Mbytes of external data and code memory. It offers a linear code space of 64,000 segmented data spaces. Moreover, the special-function-register (SFR) space, which is directly addressable, was extended to 2 kbytes. The SFR, a characteristic of the 80C51 architecture, allows peripherals, such as UARTs, timers, and serial interfaces, to connect and gain access to the CPU *(see the figure)*. The SFR actually consists of timer registers, a data register (when a serial interface is employed), and a control register. ☐

PRICE AND AVAILABILITY

Samples of the 80C51 XA will be available in the first quarter of 1995. Production should commence in the third quarter of next year. In large volumes, the ROM version will sell for about $5 to $7. The EPROM version will be priced in the $15 to $20 range. A flash-memory part is planned for 1996. The first products will be housed in 44-pin QFP and PLCC packages, and 40-pin DIPs.

Philips Semiconductors, 811 E. Arques Ave., P.O. Box 3408, Sunnyvale, CA 94088; (408) 991-2000. CIRCLE 511

HOW VALUABLE?	CIRCLE
HIGHLY	525
MODERATELY	526
SLIGHTLY	527

PICO

Low Profile .2" ht. Surface Mount Transformers & Inductors

Actual Size

All PICO surface mount units utilize materials and methods to withstand extreme temperature (220°C) of vapor phase, IR, and other reflow procedures without degradation of electrical or mechanical characteristics.

AUDIO TRANSFORMERS
Impedance Levels 10 ohms to 10,000 ohms, Power Level 400 milliwatt, Frequency Response ±2db 300Hz to 50kHz. All units manufactured and tested to MIL-T-27.

POWER and EMI INDUCTORS
Ultra-miniature Inductors are ideal for Noise, Spike and Power Filtering Applications in Power Supplies, DC-DC Converters and Switching Regulators. All units manufactured and tested to MIL-T-27.

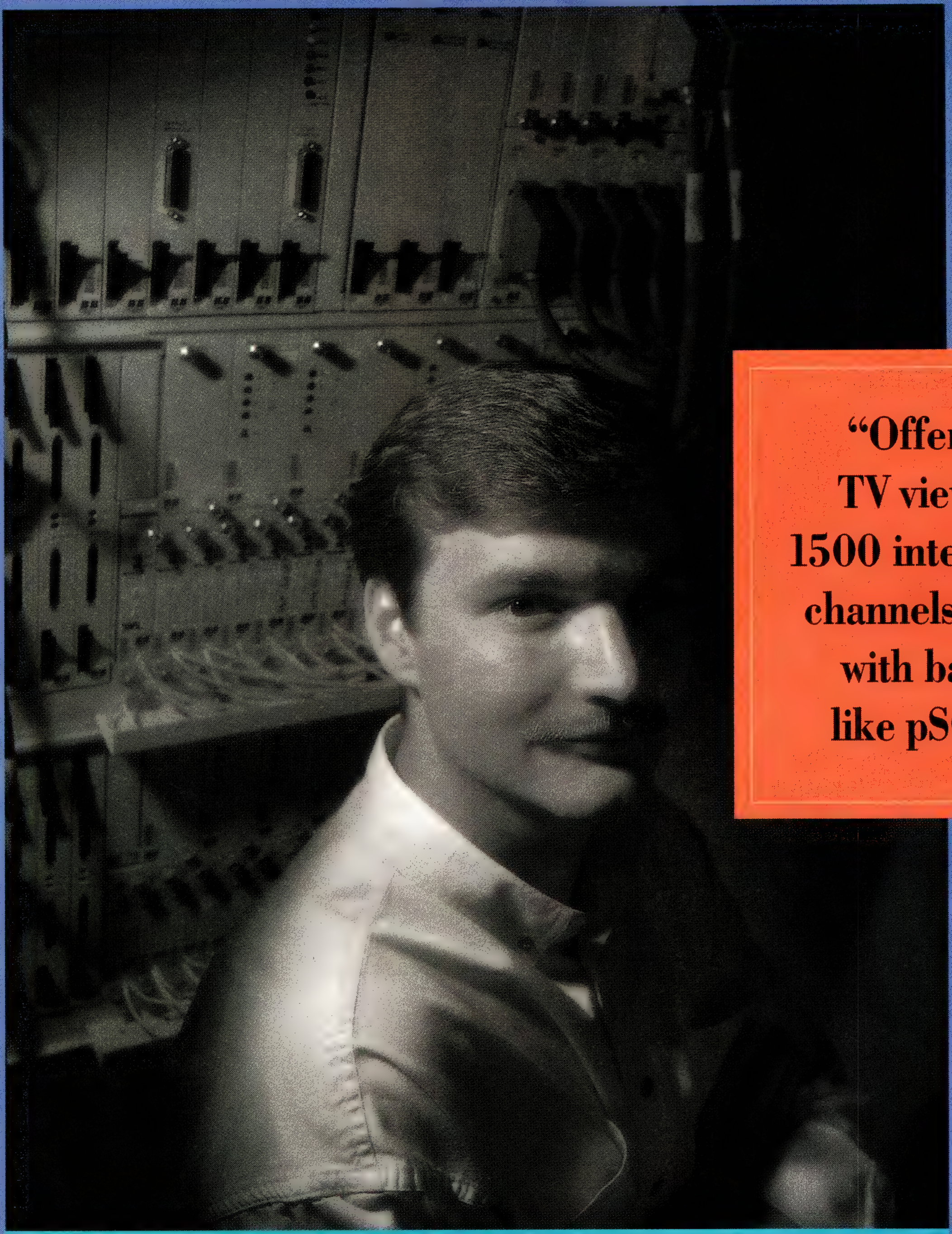
PULSE TRANSFORMERS
10 Nanoseconds to 100 Microseconds. ET Rating to 150 Volt-Microsecond. All units manufactured and tested to MIL-T-21038.

Delivery—stock to one week

See EEM
or send direct
for **Free** PICO Catalog.
Call toll free **800-431-1064**
in NY call **914-699-5514**
FAX **914-699-5565**

PICO Electronics, Inc.
453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552

READER SERVICE 247



"Offering TV viewers 1500 interactive channels starts with basics like pSOS+."

Mark Andrews
Senior Software Engineer

pSOS pROFILE: BroadBand Technologies, Inc., Research Triangle Park, NC

Designing a switched digital video system that integrates telephone, broadcast and interactive video is a real challenge. So engineers at BroadBand Technologies use the real-time operating system you can rely on. pSOS+™ from Integrated Systems. See what pSOS+ can do for you. Call 1-800-270-1115 for complete information.

integrated systems

US: 1-800-543-7767, UK: (44) 707 331199, Japan: (81) 3 5489 0171, France: (33) 1 34 65 3732, Germany: (49) 89 850 6081, Sweden: (46) 8 703 6345 © 1994 Integrated Systems, Inc.

READER SERVICE 190

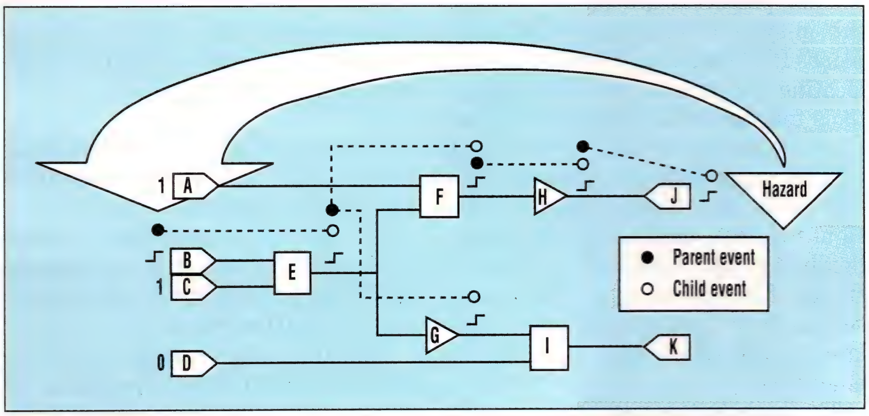
CPLD, FPGA MODELS SPEED SYSTEM DESIGN

IMPROVED MODEL TECHNOLOGY AND A DEBUGGING TOOL SUITE ACCELERATE VERIFICATION OF PROGRAMMABLE LOGIC IN A BOARD OR SYSTEM.

LISA MALINIAK

Custom logic, generally implemented in complex PLDs (CPLDs), field-programmable gate arrays (FPGAs), or ASICs, often is the critical part of a system and must be extensively tested. However, as many engineers have discovered, there usually is a vast difference between the device's performance when it's tested by itself and when it's installed in the system. Trial-and-error corrections of device designs, however, are hardly consistent with engineering teams' goals to shorten product-development time. The fact is that system interactions often are so complicated that it's nearly impossible to specify a device correctly and develop a design accurately without considering these interactions right from the start.

The best solution is to use simulation to verify FPGAs and CPLDs while they're working along with the system's other elements. That's why Logic Modeling developed an improved modeling technology, called SmartCircuit, which speeds the simulation times for high-capacity FPGAs and CPLDs. The company unveiled their original SmartModel simulation models for programmable logic devices seven years ago. The new SmartCircuit technology improves on that as well as paves the way for a new suite of tools, called PLdebug, which help troubleshoot both logic and timing errors.



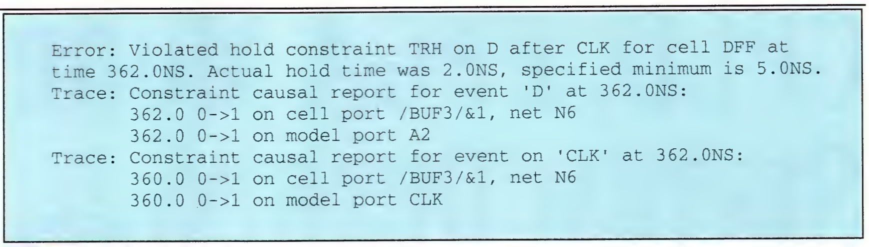
1. CAUSAL TRACING in PLdebug lets engineers see the source of logic and timing errors for specified events. In this example, a report on the event at J reveals the causal events that can be traced back to F, E, and B. Note the use of symbols to designate parent events (causes) and child events (effects).

SmartModels for programmable logic are basically templates of unconfigured devices. The models are programmed by a design net list in the format produced by the semiconductor vendor or third-party place-and-route tools, such as the Xilinx XNF format or the EDIF standard.

Logic Modeling obtains the proprietary information needed to build the templates and interprets the net list directly from the semiconductor vendor. When the board- or system-level simulation is invoked, the SmartModel automatically programs itself with the function and timing information by combining the standard device template with the user's own design configuration.

SmartCircuit technology enhances the SmartModel Library by improving model performance and speeding the model-development process, while supporting the advanced troubleshooting capabilities of PLdebug. The SmartCircuit technology brings new standard capabilities to FPGA models, including pin-mapping tools and AutoWindows.

The SmartCircuit-model kernel yields significant gains in run-time simulation performance. More important to the verification task, however, is a short debugging loop (simulate, modify the design, resimulate). The debugging process must make it possible for engineers to interact with the simulation environment at effective speeds, and identify problems and find their source.



```
Error: Violated hold constraint TRH on D after CLK for cell DFF at
time 362.0NS. Actual hold time was 2.0NS, specified minimum is 5.0NS.
Trace: Constraint causal report for event 'D' at 362.0NS:
       362.0 0->1 on cell port /BUF3/&1, net N6
       362.0 0->1 on model port A2
Trace: Constraint causal report for event on 'CLK' at 362.0NS:
       360.0 0->1 on cell port /BUF3/&1, net N6
       360.0 0->1 on model port CLK
```

2. A REPORT is generated by PLdebug when it encounters a timing-constraint violation. This particular report on a timing violation internal to a CPLD contains information on the location of the primary input events that caused the violation, and the simulation time in which the error occurred.

SHORT DEBUGGING LOOP

Logic Modeling pares down the debugging loop because, unlike many other FPGA design tools, the SmartModel library doesn't require users to exit from their EDA simulation environment and rebuild or recompile the design each time it changes. Rebuilding and recompiling the design is a time-consuming process, made worse by the high gate counts of today's devices. With the SmartModel Library, users modify the net-list description and restart the simulation run without exiting their session.

Model development using the SmartCircuit technology is based on the principle of reuse. Vendor device-specific and user design-specific descriptions are built from SmartCircuit libraries of generic primitives and cells. The SmartCircuit translator integrates individual net-list translators, such as XNF and EDIF translators, into one tool that delivers compiled configuration net lists to SmartCircuit's central database. This approach reduces the model-development effort required to support new device families and extensions to supported families. As a result, Logic Modeling can keep pace with engineers' demands for the growing numbers and types of complex programmable logic devices.

SmartCircuit aims at increasing productivity by allowing users to focus on the design and system verification task rather than simulation details. With SmartCircuit, one file controls all of the models and debugging-tool functions. In addition, SmartCircuit-based pin-mapping tools map the user-defined I/O pins to the physical-device description, automatically generating a cross reference. Autocompile automatically triggers recompilation when users make changes to the net-list description, ensuring that the active simulation reflects the most current design.

AutoWindows, an enhancement to the SmartModel Windows option, groups elements into multibit registers and buses for analysis. Engineers use SmartModel Windows to look inside devices and see accurate timing for registers and nodes. They can create and use named registers of internal device elements to simplify analysis, and can also set break points. And simulation with SmartModel Windows is an interactive process: the simulation pauses while engineers view and change the values of internal registers and nodes.

Once problems are found through the in-system simulation, the company's PLdebug tools ease the task of locating error sources. Debugging tools take on added responsibility as more engineers create FPGAs and CPLDs using high-level design methods. While text-based, high-level design methods and synthesis bring flexibility and speed to the early stages of design, this type of approach results in a device description that later on can appear as a black box to engineers.

The tools in the new PLdebug option to the SmartModel Library direct engineers to the source of logic and timing errors in their post-route design descriptions, no matter how unfamiliar it may have become as a result of synthesis, routing, or other processing. Consequently, engineers can analyze a design without having to comprehend the overall structure of the post-route FPGA or CPLD description. Without PLdebug, they may be forced to manually analyze hundreds of possible paths to identify logic and timing errors, a task made all the more difficult when the engineering team uses high-level design or a combination of structural and text-based methods.

EVENT TRACING

If engineers encounter problems with a design during a simulation run, it's helpful to trace events to see where the problem is occurring. The troubleshooting features in PLdebug use an automated history mechanism to deliver this capability. The causal-tracing tools work from user-specified trigger points to perform the following:

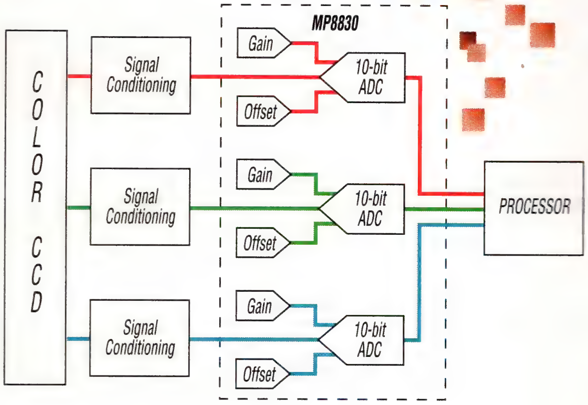
- Trace back to locate the root cause of any logic-event errors.
- Trace forward to find the effects of any specific logic event.
- Identify the root cause of timing-constraint violations.

PLdebug's reports help identify the root of a logic problem by generating a list of events internal to the FPGA or CPLD device that are causally related to the problem event. This report points back to the primary input to show which event caused the transition.

Causal-tracing reports also can be used to observe events produced by any given transition at a specified location in the design *(Fig. 1)*. Users can target multiple events and their simulation times. They also control the scope of the report to provide the

Pixel Perfect™

The Perfect Digital Picture Starts with a Perfect Pixel. Whether you're designing a color scanner or digital copier, our revolutionary MP8830 color imaging subsystem speeds up image capture and offers the highest resolution and integration available today.



The MP8830 in a Typical Configuration

Faster Display of a More Accurate Picture. The MP8830 dynamically corrects the non-uniform output from a CCD on a pixel-by-pixel basis. It provides a full 10-bit corrected signal which reduces the need for additional software computation.

Reduce System Size, Power, and Cost. Because of its unique level of integration, a single MP8830 replaces from four to ten chips in a typical three-channel CCD digitizer configuration. The MP8830 also uses less power, reduces system cost, and saves valuable design time.

Improve Your Image by Calling Micro Power Systems Today! As the leading supplier of data converters to the document imaging industry, we offer a broad line of products for signal conditioning and image digitization. For more information on the MP8830 or other MPS imaging solutions, call us today at **800-765-5350**.

MP8830 Features

- *Triple 10-Bit Analog-to-Digital Converter*
- *Simultaneous Sampling to 1.25 MSPS*
- *9-Bit Gain and 6-Bit Offset Adjustment on Each Channel*
- *ESD > 2000 Volts*
- *Low Power 500mW (typical)*
- *Latch-Up Free*

Micro Power Systems
an EXAR company
3100 Alfred Street, Santa Clara, CA 95054
phone: (408) 727-5350 • fax: (408) 562-3605
e-mail: marcom@mpsi.com

MPS and Micro Power Systems are registered trademarks of Micro Power Systems, Inc. Copyright 1994

proper level of information for each stage of the debugging process.

PLdebug provides similar advanced troubleshooting for timing errors. Timing-constraint violations, such as a setup-and-hold error, are reported with information on the location of the primary input events that caused the violation and the simulation time in which the error occurred *(Fig. 2)*. This capability goes beyond simply reporting an error, and can save engineers hours or days of manual debugging.

SmartBrowser and SmartCircuit Monitor are two additional PLdebug tools. These products let engineers navigate through large, complex designs after they're flattened, optimized, and fitted to the point that the original structure is lost. SmartBrowser provides a view of the FPGA or CPLD that doesn't require users to understand the post-route net-list description to debug a design. Users can view internal states, traverse up and down the logic hierarchy, traverse forward and backward from any point, place causal traces for later simulation, and view and modify timing interactively—all with natural-language commands.

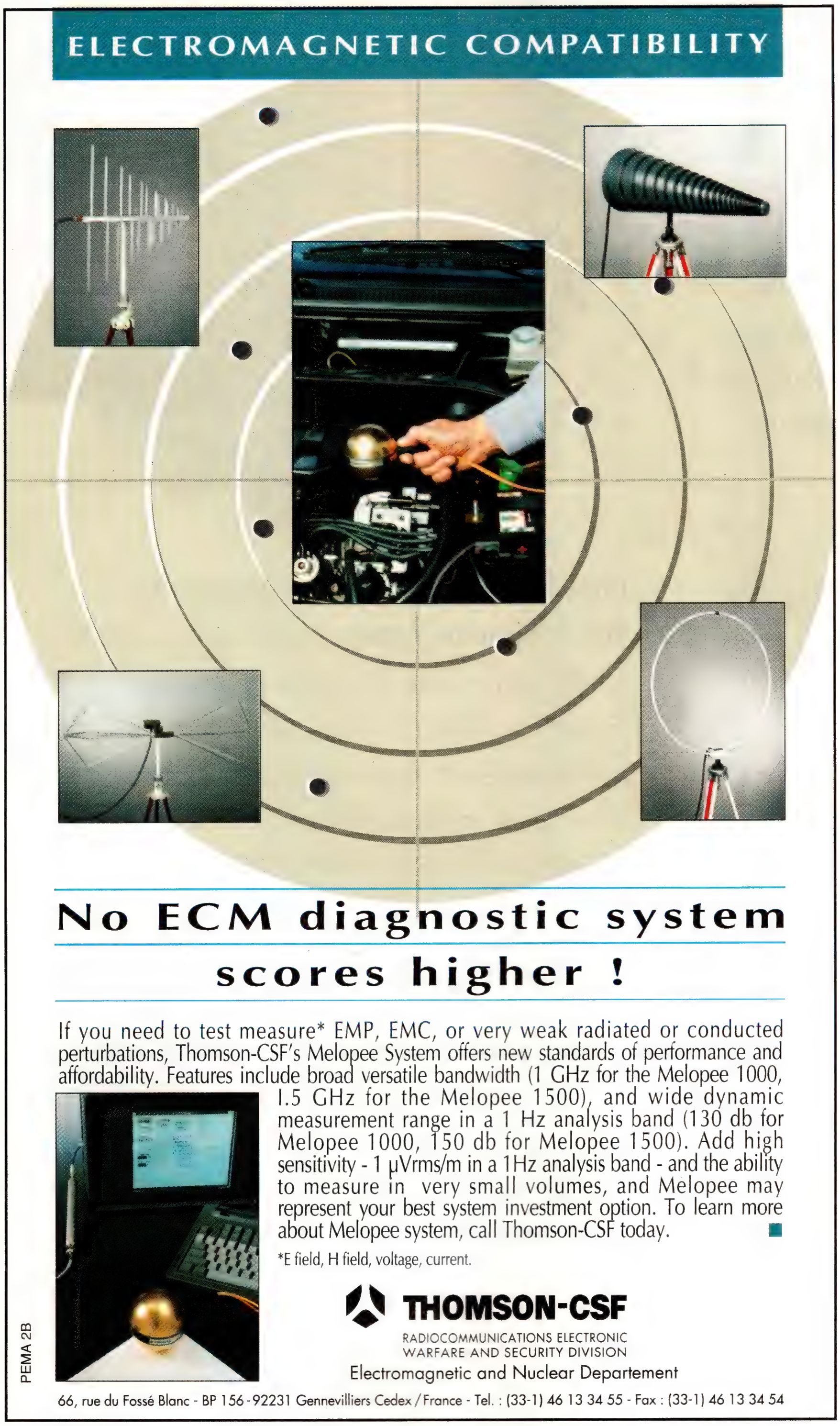
SmartCircuit Monitor acts as a probe to view any internal state or net within a user's design, opening up the "black-box" description. Users may specify particular instances, nets, and ports for monitoring during the simulation run. SmartCircuit Monitor issues back a listing of the states of these elements over time, making it possible to track the instruction flow. ☐

PRICE AND AVAILABILITY

SmartCircuit models are incorporated in the SmartModel Library subscription, which also contains models for thousands of other devices, including microprocessors. An annual subscription that includes new models, updates, and support is priced at $12,900 for a single, networked license copy. PLdebug is sold as an option to the Library for $5900. Both products are available now. Pricing is for North America only.

The Logic Modeling Group of Synopsys Inc., 19500 N.W. Gibbs Dr., Beaverton, OR 97006; (800) 344-0004. **CIRCLE 513**

HOW VALUABLE?	CIRCLE
HIGHLY	531
MODERATELY	532
SLIGHTLY	533


ELECTROMAGNETIC COMPATIBILITY

No ECM diagnostic system scores higher !

If you need to test measure* EMP, EMC, or very weak radiated or conducted perturbations, Thomson-CSF's Melopee System offers new standards of performance and affordability. Features include broad versatile bandwidth (1 GHz for the Melopee 1000, 1.5 GHz for the Melopee 1500), and wide dynamic measurement range in a 1 Hz analysis band (130 db for Melopee 1000, 150 db for Melopee 1500). Add high sensitivity - 1 µVrms/m in a 1Hz analysis band - and the ability to measure in very small volumes, and Melopee may represent your best system investment option. To learn more about Melopee system, call Thomson-CSF today. ■

*E field, H field, voltage, current.

THOMSON-CSF
RADIOCOMMUNICATIONS ELECTRONIC
WARFARE AND SECURITY DIVISION
Electromagnetic and Nuclear Departement

66, rue du Fossé Blanc - BP 156 - 92231 Gennevilliers Cedex / France - Tel. : (33-1) 46 13 34 55 - Fax : (33-1) 46 13 34 54

PEMA 2B

READER SERVICE 138

This kind of breakthrough calls for an

ONCORE

Preview the Motorola 8-channel Oncore GPS at ION—Booth A

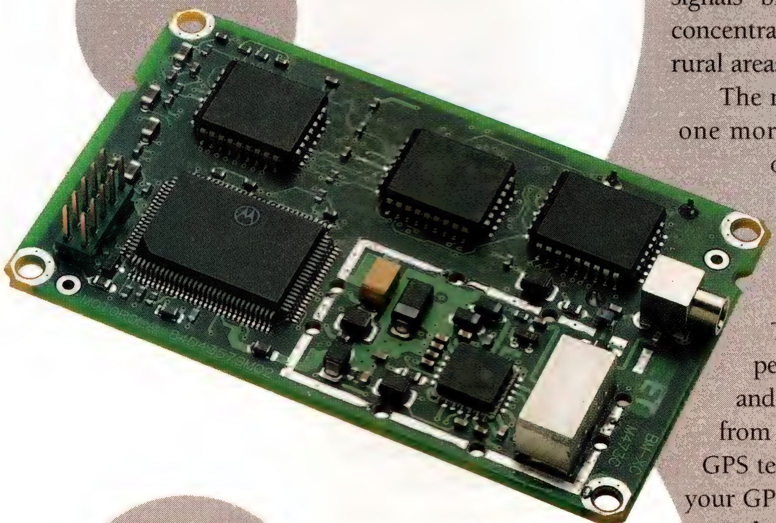
Announcing the 8-channel Oncore GPS receiver from Motorola

There's a new breakthrough in GPS technology — and a new innovation in the full line of quality Oncore GPS receivers: the new 8-channel Oncore from Motorola.

Developed specifically for automotive applications, this new 8-channel Oncore has evolved from Motorola's 65 years of experience and dedication to the automotive and trucking markets.

Our new Oncore helps satellite signals "break through" in highly concentrated urban canyons and in rural areas with heavy tree cover.

The new 8-channel Oncore is one more example of Motorola's ongoing commitment to producing high quality GPS electronics that meet your most demanding specifications. This new Oncore has all the performance, all the flexibility and all the quality you'd expect from a high volume leader in GPS technology, Motorola. We are your GPS partner.



VP Oncore
(Actual Size)

To learn more about Motorola's 8-channel Oncore, in the U.S.A. call:

708.205.3490
800.421.2477
708.205.3482 fax

In Europe call:

+49.611.3611.259
+49.611.3611.266 fax

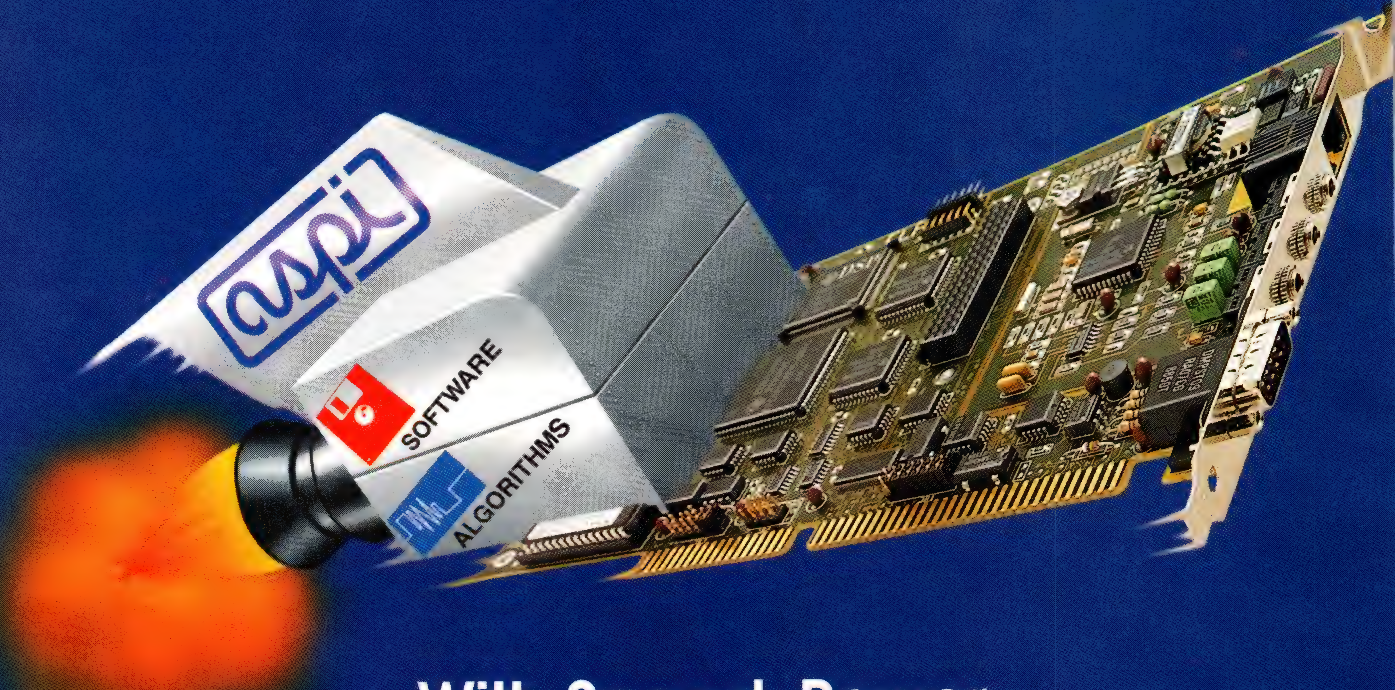
ONCORE
QUALITY GPS BY MOTOROLA

MOTOROLA

Motorola, Ⓜ and ONCORE are registered trademarks of Motorola, Inc. ©1994 Motorola, Inc.

READER SERVICE 119

Elf Launches DSP Applications!



With Speed, Power and Accessories

ASPI provides everything you need to launch products using Digital Signal Processing technology. For speed, power and accessories, look to the Elf DSP Platform and Application Toolkits from Atlanta Signal Processors.

Platform: Designed for AT-compatible computers, the Elf DSP Platform includes a Texas Instruments TM320C31 floating-point DSP, a stereo high-quality 16-bit A-D/D-A converter, and a telephone line interface (DAA). All for a remarkably low price!

Algorithms: ASPI offers the most complete library of DSP algorithms available anywhere. It includes MPEG audio, state-of-the-art speech coders and many industry-standard techniques for music and telephony.

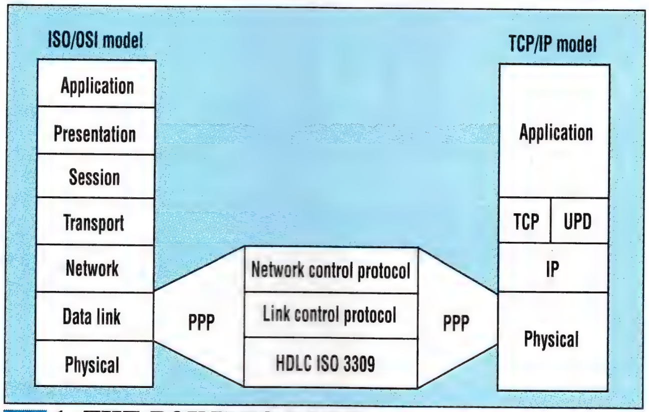
Software: The Toolkit's DSP Operating System and host interface software allow easy integration into host applications. The development environment features a Loader, an Assembler, a C Compiler, and a C Source Debugger. Together, these tools enable software developers and OEMs to develop a single programmable hardware product that offers powerful capabilities.

If you are considering DSP for your applications, the Elf Application Toolkit is now available. The Evaluation Toolkit includes the Elf DSP Platform and demos of many DSP algorithms, including those found in the Developer's Toolkit. Contact Atlanta Signal Processors, Inc. today for complete details.

aspi

Atlanta Signal Processors, Inc., 1375 Peachtree Street NE, Suite 690, Atlanta, GA 30309
Telephone 404/892-7265 FAX 404/892-2512
Germany: MEDAV, phone (09131) 583-0 Japan: Kobe Steel, phone 3 (5634) 5426

READER SERVICE 201



1. THE POINT-TO-POINT PROTOCOL resides in the link layer of the OSI communications protocol stack. It provides a method of bridging between WAN and LAN protocols using HDLC data packets.

FIRST SILICON IMPLEMENTATION OF POINT-TO-POINT PROTOCOL TO EXPEDITE ADVANCED REMOTE NETWORKING EQUIPMENT.

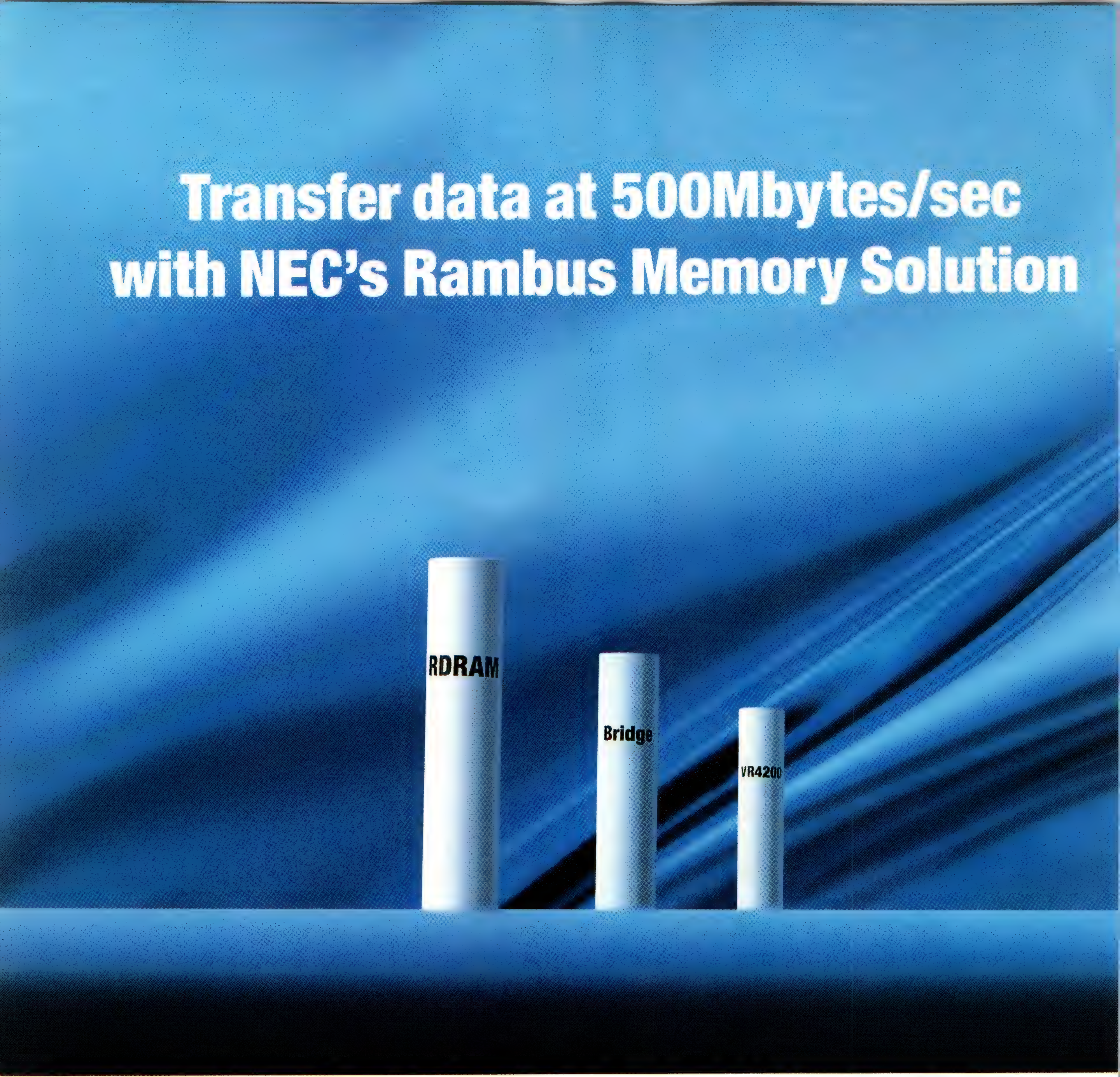
CONTROLLER IC SIMPLIFIES REMOTE NETWORKING

LEE GOLDBERG

Engineers developing the next generation of remote networking devices recently gained a powerful new tool in their quest to decouple users from the physical constraints of traditional local-area networks (LANs). The latest network controller chips offered by Cirrus Logic will enable networks to make seamless connections between remote devices or other networks over ordinary telephone lines.

Able to support up to four synchronous or asynchronous channels at rates of up to 115 kbits/s, the CL-CD2430 and 2431 controllers use the newly developed Point-to-Point Protocol (PPP) to extend the full functionality of the network to remote sites. PPP provides a way to encapsulate most common LAN control protocols for transmission over public wide-area networks (WANs) such as the Internet and the telephone system. Once established, a PPP link creates a seamless logical bridge between two networked devices *(Fig. 1)*. This means that instead of struggling to communicate via special remote-access software or clumsy terminal emulators, remote users will be able to log into and work on their LANs using an environment (X-Windows, Appleshare, Windows NT, etc.) that behaves as if they were physically connected to their server.

Although not yet an official standard, PPP has gained popularity and support because of its flexibility, robust error handling, and ability to easily accommodate new protocols as they arrive. PPP is the successor to the Serial-Line Internet Protocol (SLIP), a simple, single-purpose protocol originally developed to transmit Internet Protocol (IP) data


Transfer data at 500Mbytes/sec
with NEC's Rambus Memory Solution
RDRAM
Bridge
VR4200

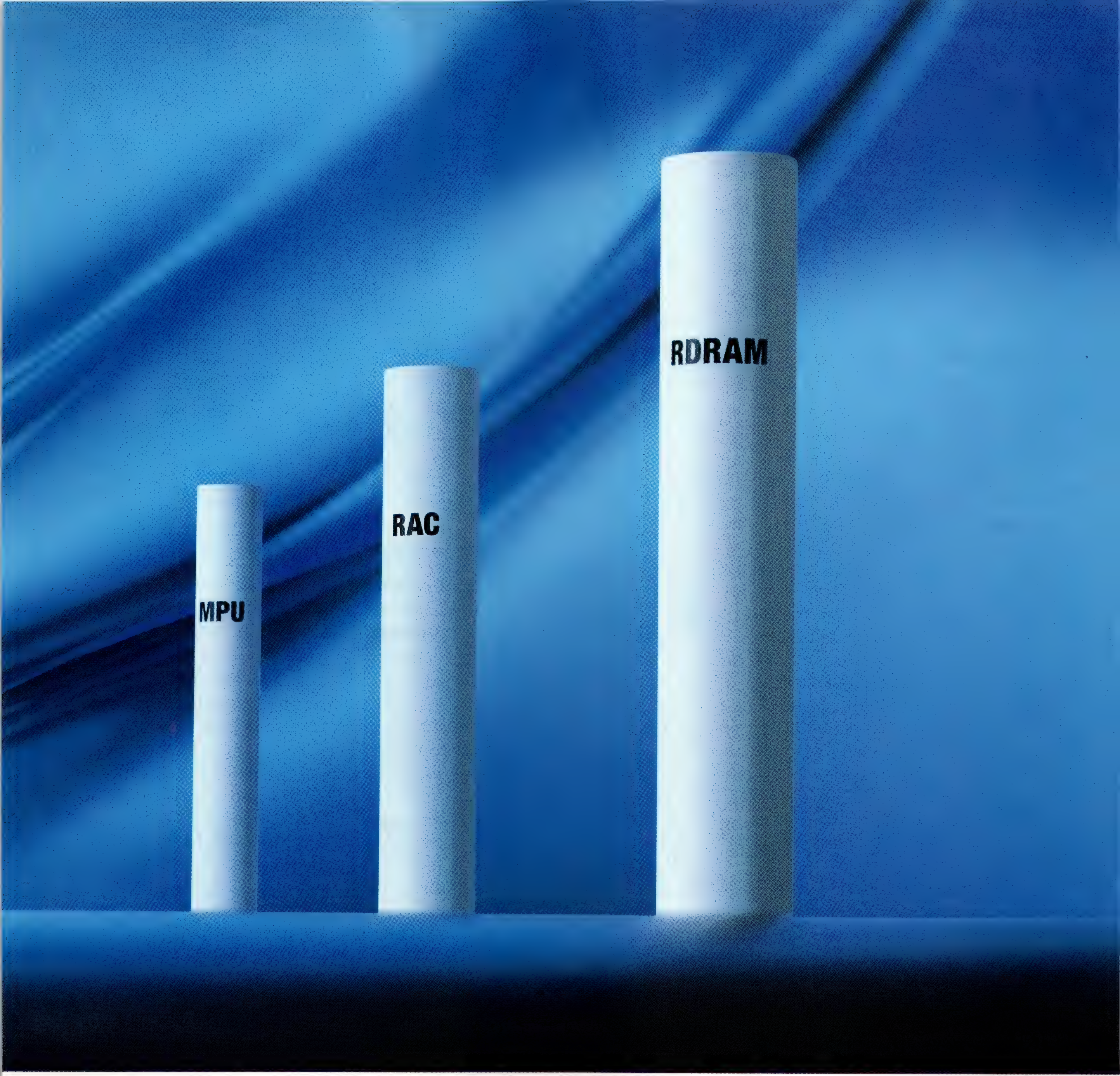
NEC offers 16M and 18M Rambus DRAMs with interface bridges

Now there's a memory to match the spiralling speed of the latest microprocessors. NEC's Rambus™ DRAM (RDRAM™) operates at 250MHz. It transfers data at the unparalleled rate of 4 billion bits per second. Superior performance makes RDRAMs the ideal graphics memory for high-end multimedia systems, desktop computers and workstations.

NEC is the first and only vendor offering 16M and 18M RDRAMs. We also provide the interface chips you need to implement the industry's most advanced memory solution.

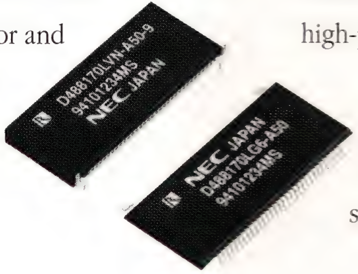
NEC's RDRAMs are fabricated with a 0.45-micron CMOS process. They operate on 3.3V. Organizations are 2M x 8 and 2M x 9. Package options are a 32-pin Surface Vertical Package (SVP) and a 32-pin SSOP. These space-saving

For fast answers, call us at: USA Tel:1-800-366-9782.Fax:1-800-729-9288. Germany Tel:0211-650302.Fax:0211-6503490. The Netherlands Tel:040-445-845.Fax:040-444-580. Sweden Tel:08-753-6020.Fax:08-755-3506. France Tel:1-3067-5800.Fax:1-3946-3663. Spain Tel:1-504-2787.Fax:1-504-2860. Italy Tel:02-6709108.Fax:02-66981329. UK Tel:0908-691133.Fax:0908-670290. Ireland Tel:01-6794200. Fax:01-6794081.Hong kong Tel:886-9318.Fax:886-9022. Taiwan Tel:02-719-2377.Fax:02-719-5951. Korea Tel:02-551-0450.Fax:02-551-0451. Singapore Tel:253-8311.Fax:250-3583. Australia Tel:03-8878012.Fax:03-8878014. Japan Tel:03-3454-1111.Fax:03-3798-6059.



package styles make RDRAMs an excellent choice for the main memory in PCs and workstations.

NEC's Rambus ASIC Cell (RAC™) is a macro for our 0.5-micron CB-C8 family. It provides an efficient interface between the microprocessor and the RDRAMs. The CB-C8 ASIC gives you true 3V operation. It also ensures safe interface with 3.3V and 5V components.



Designers of multimedia terminals and games can gain a powerful price/performance edge by combining RDRAMs with our VR4200 64-bit RISC microprocessor. The Rambus interface bridge permits easy implementation of low-cost, high-performance systems.

Whether you're designing multimedia systems, desktop computers or workstations, RDRAMs make memory-intensive applications run at 21st-century speed. For more information, call NEC today.

NEC

Rambus, RDRAM and RAC are trademarks of Rambus Inc.

READER SERVICE 123

packets between Internet nodes. The Internet Engineering Task Force began work on PPP in 1989 when it became apparent that the SLIP's limited functions couldn't support the growing need to interoperate with the expanding number of new LAN protocols.

SIMPLIFED REMOTE ACCESS

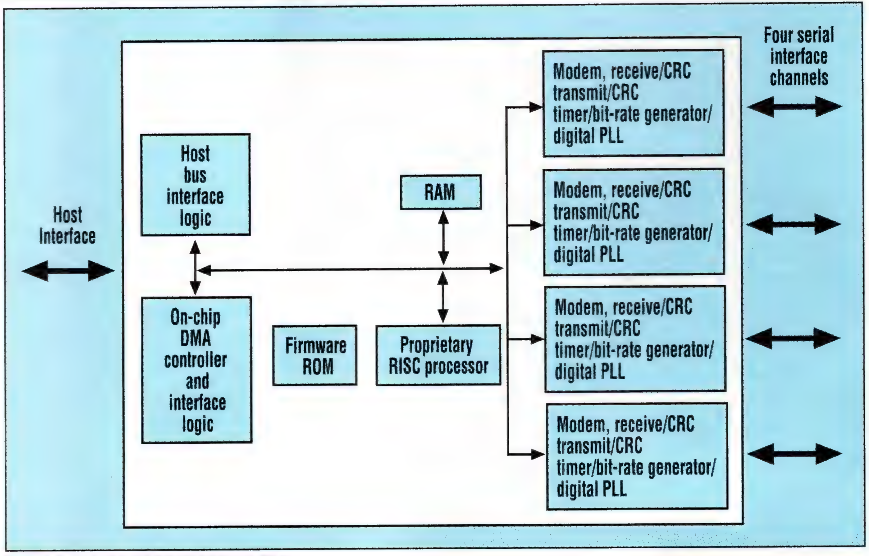
In essence, PPP provides a standard mechanism for encapsulating higher-level LAN protocols (Netware, Appletalk, DECnet, PC/TCP, etc.) within a signaling and control structure appropriate for WAN transmission. Encapsulation of LAN communications is done at the data-link level of the protocol stack defined by the International Standards Organization's (ISO's) Open Systems Interconnect (OSI) reference model.

PPP takes the HDLC packet generated by the LAN and attaches a 16-bit protocol identifier that describes the type and contents of the packet. Three types of PPP packets are used for communication: the Link-Control Protocol (LCP), the Network-Control Protocol (NCP) frames for higher-level protocols, or actual data.

LCP packets are used to establish a PPP link between two nodes, checking to see if both sides can support a specific high-level LAN protocol such as IPX or Appletalk. This accomplished, LCP then negotiates the class of service (bit rate, maximum packet size, and authentication procedures) that will be supported.

Once a link is established, LCP is used as an in-band signaling channel for other link-level control functions. The LANs then use the link to pass NCP control frames between themselves to configure one another and invoke the higher-level control functions used by the encapsulated network protocols. These high-level control protocols also are responsible for terminating the link at the end of the session.

The secret of PPP's adaptability is the modular nature of its structure, which allows it to accept code to handle various network protocols. Whatever its form, PPP adheres to strict standards requirements for link-parameter negotiation and protocol encapsulation, while interchangeable code for ICP handling allows it to accommodate the rich and varied command sets used by today's LANs. In addition to simply connecting one LAN to another, high-level protocol software was developed to support functions such as bridging.


Host Interface
Host bus interface logic
On-chip DMA controller and interface logic
Firmware ROM
RAM
Proprietary RISC processor
Modem, receive/CRC transmit/CRC timer/bit-rate generator/ digital PLL
Modem, receive/CRC transmit/CRC timer/bit-rate generator/ digital PLL
Modem, receive/CRC transmit/CRC timer/bit-rate generator/ digital PLL
Modem, receive/CRC transmit/CRC timer/bit-rate generator/ digital PLL
Four serial interface channels

2. AN EMBEDDED RISC processor drives the host interface and four independent PPP-compliant serial interface channels on Cirrus Logic's controller. An efficient architecture offloads the host processor and supports data rates of up to 115 kbits/s on each channel.

Security issues also are addressed with PPP via a two-way password authentication protocol that may be invoked optionally at the beginning of a session. If further security is desired, a second protocol can be used. This protocol would challenge the receiver with an ID/password pair at random intervals of time during the hookup.

OVERHEAD HANDLING

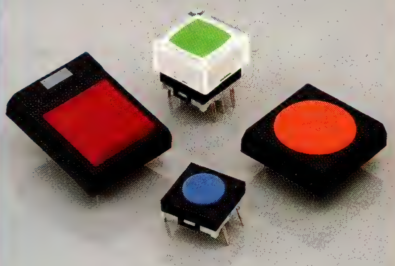
While PPP is a highly effective means of providing an "on-demand WAN," the processing overhead required to support this complex protocol is significant, especially at the high data rates provided by the new V.32 and V.34 modems. Until now, PPP has been implemented in software running on the host's CPU, sacrificing the number of MIPS that might be used for other tasks. Cirrus' new controller chips contain an embedded RISC processor that performs virtually all of the processing tasks required to establish and maintain a remote LAN connection, thus offloading the host computer and simplifying the host software interface *(Fig. 2)*.

In addition to performing the encapsulation, framing, flow-control, security, and error-handling functions associated with PPP, the CLCD243X chips employ 32-bit, double-buffered DMA channels for passing data to and from the CPU. This on-chip direct memory access provides "fire and forget" data movement, requiring minimal attention or interrupt servicing from the host's CPU. DMA efficiency is further enhanced by a 16-byte transmit and receive buffer FIFO circuit with a programmable threshold. For applications in which direct memory access isn't desired, the device may be operated in an interrupt-driven or polled mode. Data-word size can be set at 8 or 16 bits with selectable byte-endian orientation, enabling the chip to smoothly pass data between 80X86 or 680X0 processors.

Each of the chip's four serial channels may be configured to support either asynchronous, asynchronous high-level data-link control (HDLC), or HDLC and synchronous data-link control (SDLC) bit-synchronous transmissions. In the synchronous mode, the chips perform frame-check-sequence (FCS) generation and validation and can handle either 8- or 16-bit frame-address matching.

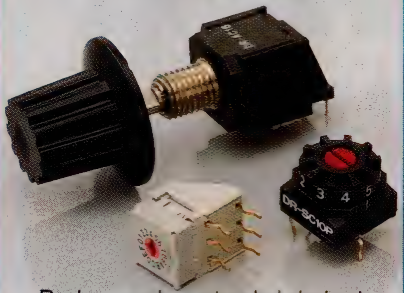
Other synchronous-mode features include programmable leading-pad characters and leading flags, as well as the option to read frame cyclic redundancy checks (CRCs). In the asynchronous mode, flow control may be accomplished in-band via software-generated XON/XOFF commands or

KEYS TO SUCCESS



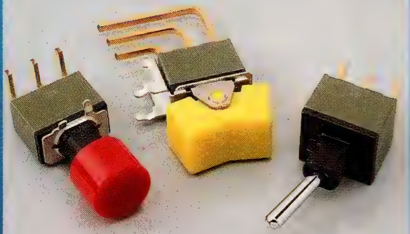
Dome contact, low profile keypad switches. Lighted & non-lighted, round & square. Sub-surface mounting types. Up to 5 million actuations.

FLAWLESS LOGIC



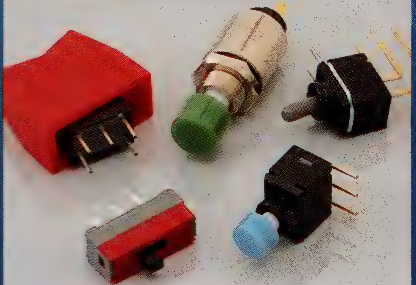
Real or complement coded, decimal or hexidecimal dip rotaries. Screwdriver, shaft or dial actuation. Washable.

WASH AND GO



NKK washables lead the way with the industry's widest range of circuits, actuators, terminals & accessories. Micro thru std. sizes.

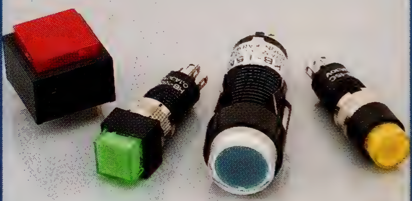
LITTLE GIANTS



NKK pioneered the smallest. Toggles, rocker, pushbutton, slides. Washables, SMDs, anti-static & STC contacts available.

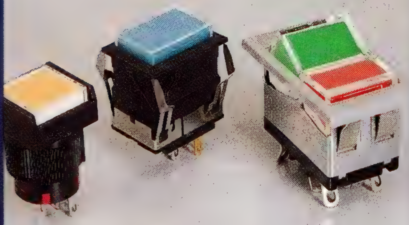
FREE DESIGN TOOL

LIGHT FANTASTICS



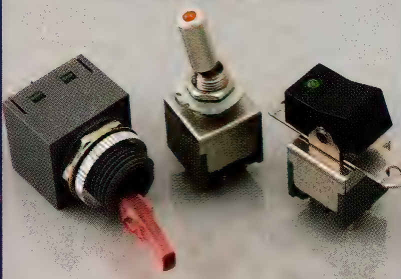
Tiny, but bright. Low-profile snap-in or panel mounting. Numerous actuators, circuits, ratings, terminals and colors.

WAYS TO GLOW



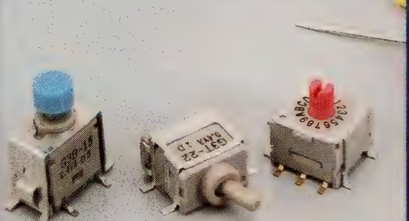
Round, square, rectangle shapes. In all popular colors. Wide choice of terminals, circuits, lamp types & accessories.

POINTS OF LIGHT



Lighted toggle and paddle tips add style and function to designs. Several actuator and circuit options.

STAY ON TOP



The latest surface mount technology. Washable, vapor phase solderable toggles, pushbuttons and dip rotaries. Gull-winged terminals.

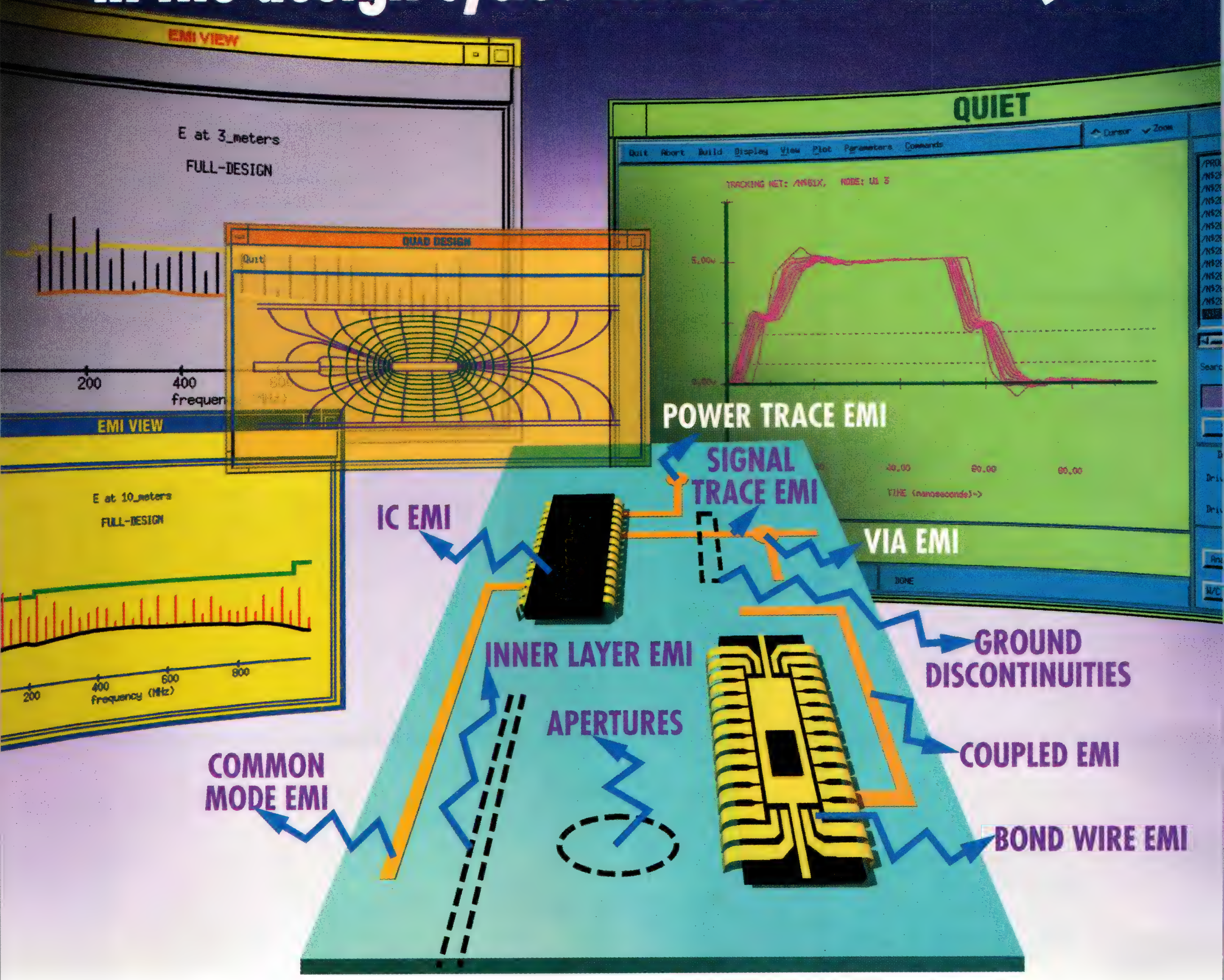
DESIGN PARTNERS

We have exactly what every design engineer needs — over one million switch options and more than 40 years of switch know-how. Before you start your design-in, call for our 456-page Design Guide, then call on our experience. Make sure your design-ins go flawlessly. Make NKK your design partner right from the start.

Call NKK Switches,
(602) 991-0942
7850 E. Gelding Dr.,
Scottsdale, AZ 85260
FAX (602) 998-1435.

nkk® switches

Identify potential EMI problems early in the design cycle: Rafordiate* with QUIET™



Accurately predict radiated noise in PCBs.

It's your choice. Discover radiated noise at the *beginning* of the design cycle . . . or wait until the end.

We recommend the beginning. Instead of building a prototype and running into EMI roadblocks down the line, now you can simulate open-field tests and predict actual network waveforms *during the initial design cycle!*

The key is QUIET, the industry's first integrated EMI tool kit. Quad Design's proven transmission line simulation technology is employed by QUIET to predict signal waveforms. These waveforms are then used to propagate in space the frequency-dependent electric and magnetic field intensities. The result is optimized designs that eliminate the need for repetitive prototyping and costly re-testing.

Of course, QUIET is available only from Quad Design, the industry's premier source of scalable analysis tools for high performance design applications.

Zero in on and quantify EMI problems on backplanes, motherboards and MCMs by rafordiating with QUIET. It's quick. Accurate. And automatic. Call Quad Design at (805) 988-8250 for a brochure on our whole family of predictive tools. 1385 Del Norte Road, Camarillo, CA 93010 . . . FAX (805) 988-8259.

QUAD DESIGN
A Viewlogic Company

* **Rafordiate** *(rə fôr'dē āt')* vt. **-a ted, -a ti**
[RA . . . DIATE . . . L. radiatus, *pp. of* radiare, *to radi*
+ FOR (FORECAST) . . . ME. forecasten, *to estimate*
calcuate in advance; predict] **1.** *to forecast radiat*
noise from printed circuit boards **2.** *to find layo*
EMI problems without prototyping **3.** *to exist in t*
future presently — ***ra-for'di-a'tion*** n.

READER SERVICE 156

COMMUNICATIONS CONTROLLER

by using out-of-band Request-to-Send/Clear-to-Send (RTS/CTS) and Data-Terminal-Ready/Data-Set-Ready (DTR/DSR) hardware signals. The controller can employ either of the two techniques specified by HDLC (bit-stuffing or control-character mapping) to help it distinguish between data-flow control characters and data characters.

Applications for the controllers are expected to range from single-user modems that support PPP to full-blown network modem servers. Direct software compatibility with the earlier CL-CD2400 controller series will help speed product development.

Due to the low cost-per-port that the chips offer, manufacturers can provide inexpensive PPP access points for networks. As PPP becomes more popular, it's anticipated that a variety of PPP-compliant bridges and routers will be developed to help users extend their LANs at will via the public switched telephone network. In anticipation of these large, multichannel applications, the CL-CD243X architecture was designed to facilitate multiple-device cascading with appropriate handshaking controls and external data lines.

If the PPP protocol gains acceptance, the Cirrus controller will provide common the ground between networks and remote systems that the WAN environment has been waiting for. ☐

PRICE AND AVAILABILITY

Both the CL-CD2430 and CL-CD2431 are available immediately in production quantities. Both chips are functionally identical and differ only in their pinouts; the CD2430 is designed to support seven clock/modem signals per channel while the CD2431 supports ten. Both chips are available in either an 84-pin PLCC or a 100-pin plastic QFP. Pricing is $28 each in quantities of 1000 with discounts for higher volumes.

Cirrus Logic Inc., 3100 W. Warren Ave., Fremont, CA 94538; Mike Leung, (510) 226-2041.

For further information on PPP, contact Fred Baker, chairman of the PPP working group of the Internet Engineering Task Force, at (805) 605-4455. **CIRCLE 514**

HOW VALUABLE?	CIRCLE
HIGHLY	546
MODERATELY	547
SLIGHTLY	548

We look for church organists with typing experience!
DOYS

Turn your **excess inventory** into a
substantial tax break and help
send needy **kids to college** as well.

Call for your **free guide** to learn how
donating your slow moving inventory can
mean a generous **tax write off** for your company.

Call (708) 690-0010
Peter Roskam
Executive Director

EAL

P.O. Box 3021, Glen Ellyn, IL 60138
FAX (708) 690-0565

Excess inventory today...student opportunity tomorrow

PRODUCTS NEWSLETTER

96-CHANNEL INTERFACE TARGETS AVIONICS

Providing 96 inputs that accept binary status information from aircraft devices, such as switches, relays, solenoids, or lamps, the DD-03296 discrete-to-digital interface simplifies the design of data concentrators, data- and information-management systems, avionic displays, and environmental-control systems.

The interface device, which comes from from ILC Data Device Corp., Bohemia, N.Y., combines a mixed-signal IC, thick-film resistors, a ceramic substrate, and surface-mount technologies along with autonomous built-in self-test capabilities (with fault reporting). The internal precision R-C input networks and on-chip comparators provide universal inputs with immunity to high-intensity radiated fields (HIRF) and lightning effects. Input debouncing logic also is included, and for each bank of 32 input-channel comparators there are three independent reference inputs.

Input conditions that can be sensed include open/ground, 28-V/open, or 28-V/ground pairs. The circuit's parallel output is selectable as an 8- or 16-bit three-state TTL format for easy connection to most microprocessors or other intelligent devices. An optional ARINC 429 data concentrator port is also available. The DD-03296 is housed in a 162-lead surface-mount package that occupies just 2.3 in.^{2} and sells for $285 each in small quantities (plastic package, commercial temperature range). Contact Mike Johnson, (516) 567-5600. *DB* **CIRCLE 920**

SINGLE CHIP MERGES EEPROM AND GATE ARRAY

The AT88SC000 series of logic circuits, which combine the flexibility of gate arrays with the reprogrammable capabilities of EEPROM memories, are particularly well suited for portable electronic systems. The family of combined memory and gate-array chips, developed by Atmel Corp., San Jose, Calif., offers six combinations of EEPROM (1 kbit to 16 kbits), with gate arrays ranging from 800 to 10,000 gates. The internal EEPROM is organized as an array of 8-bit-wide words and can be accessed in either a serial or parallel mode. All EEPROM sections are guaranteed for a minimum of 10,000 erase/write cycles and 10-year data retention.

Housed in thin (1-mm thick), surface-mount packages, the combined gate array and EEPROM is ideal for use in many space-limited applications—Type-1 PCMCIA cards, smart cards, cellular telephones, pagers, and others. The circuits can operate at low power levels, with power supplies ranging from 2.7 to 5.5 V. The arrays, also available in PQFP and PLCC packages, are supported by Cadence, Viewlogic, and Mentor design toolkits. In lots of 10,000, the SC250, which includes 2 kbits of EEPROM and 5000 gates, goes for $4.50; the 800-gate version of the chip is $1.50. NRE charges start at $25,000. Contact Jean Pierre Benhammou, (719) 540-1834. *DB* **CIRCLE 921**

DRAM CONTROLLER OFFERS MANY SETUP OPTIONS

Based on a programmable sequencer, the 74ABT4764—a biCMOS DRAM controller from Philips Semiconductors, Sunnyvale, Calif.—allows designers to set up a custom control-sequence pattern by loading in a simple assembly-language program that defines the desired input and output signal sequences. The programming functions include conditional or unconditional single-step increments, jumps, calls, and returns.

After it's defined, the program is translated into a serial bit stream, which then can be stored in a PROM or on disk and loaded upon system startup through the controller's serial input port. Dual memory ports allow the controller to interface easily with CISC, RISC, or DMA channels. Thanks to the 80-MHz on-chip sequencer, the DMA portion can transfer up to 640 Mbytes/s. The controller directly drives 4 Mbytes of DRAM with row/column address multiplexing, but with a few inexpensive off-chip gates, the address range can be extended to 16 or 64 Mbytes. Memory-access modes include page, fast page, interleaved page, nibble, and static column. Housed in a 100-lead PQFP, the chip operates with 4.5- to 5.5-V supplies over a 0 to 70°C range. In lots of 1000, the 74ABT4764 sells for $30 each. Contact Mike Magdaluyo, (408) 991-2642. *DB* **CIRCLE 922**

Edited by Clifford Meth

“A great time to introduce a new luxury cruise line. The economy was in a slump, and the competition was on the rise.

"Increasing our ad budget was so successful, our agency recommended we cut it."

We told our new advertising agency we have to go in with all guns blazing. And gave them the extra money to do it.

They recommended a three phase campaign. Phase 1. Full page newspaper. One ad a week for 24 weeks and one-third pages in the travel section. Phase 2, radio. Then 3, television to sweep up one season and sow the seeds for the next.

To make a long story short, two-thirds into the newspaper phase, Celebrity's ships were just about full to the end of the season. With so little left to sell, we all agreed to hold the radio and TV and save the remainder of the budget.

In roughly two years Celebrity became the number one cruise line from New York to Bermuda.

We've just added another new luxury ship and we're anxious to fill it. So once again we've upped our budget. So far, our agency hasn't tried to talk us out of it.”

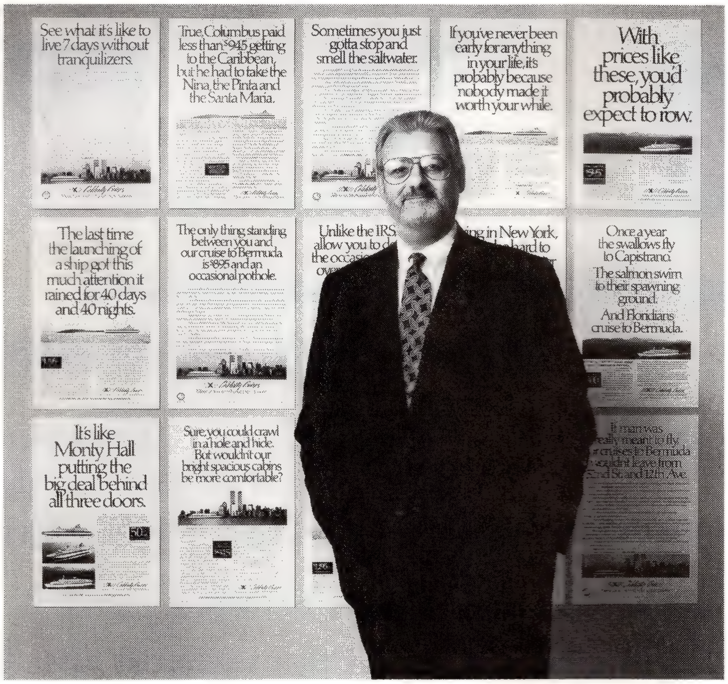

See what it's like to live 7 days without tranquilizers.
True, Columbus paid less than $945 getting to the Caribbean, but he had to take the Nina, the Pinta and the Santa Maria.
Sometimes you just gotta stop and smell the saltwater.
If you've never been early for anything in your life, it's probably because nobody made it worth your while.
With prices like these, you'd probably expect to row.
The last time the launching of a ship got this much attention it rained for 40 days and 40 nights.
The only thing standing between you and our cruise to Bermuda is $895 and an occasional pothole.
Once a year the swallows fly to Capistrano. The salmon swim to their spawning ground. And Floridians cruise to Bermuda.
It's like Monty Hall putting the big deal behind all three doors.
Sure, you could crawl in a hole and hide. But wouldn't our bright spacious cabins be more comfortable?

Photo: Frank Moscati

Al Wallack, Sr. VP Marketing, Celebrity Cruises, after returning from having his hearing checked.

AAAA

American Association of Advertising Agencies

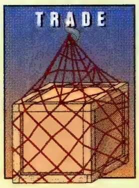
If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, NY 10017 enclosing a check for five dollars. You will receive our booklet, *It Works! How Investment Spending In Advertising Pays Off.* Please allow 4 to 6 weeks for delivery.

This advertisement prepared by Korey, Kay & Partners, New York.

COMPLIMENTARY ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:



- Telecommunications
- Computers
- Semiconductors
- International trade

☐ **YES!** Send me my **FREE** issue of ***ELECTRONICS*** and enter my 1-year subscription, 23 issues—**for 10% off the regular subscription rate!** If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates (U.S. funds drawn from a U.S. bank):

☐ U.S. ~~$98~~ $88 ☐ Canada ~~$120~~ $108 (plus GST) ☐ Other Countries ~~$190~~ $171

Please bill my credit card: ☐ Visa ☐ MasterCard ☐ AMX ☐ Discover

Card No. ______________________ Exp. Date ______________________

Signature ______________________ Date ______________________

Name ______________________ Title ______________________

Company ______________________

Mailing Address ______________________

Order by FAX: 216/696-6413 or call 216/696-7000, x 4137

1EDh4

IT'S CALLED NATURAL SELECTION.

One size *doesn't* fit all

In simulation tools, as in anything else, there comes a time when a once-useful contributor just can't cut it anymore.

Issues like mixed digital and analog signals migrating from board to chip level are forcing general-purpose simulators into extinction. They just haven't been able to adapt. And "kludging" together different simulators from different vendors has been, at best, unrewarding.

That's why Viewlogic offers you the only real survival path. We give you the tools you need to simulate at the component *and* the system level *in the same environment.* You match the best simulation tool to each task, and get instant access to all the information generated across all the tools.

An environment that's open to change

How can we do this? With Viewlogic's SimBus™ — the first simulation backplane that lets you simultaneously integrate a nearly infinite variety of simulation tools — yours, ours, or third-party — into one design environment. With SimBus you get a unified simulation environment that:

- Allows you to select the best simulator for each specific design task;
- Enables you to combine all your simulation capabilities into one comprehensive system solution which you can then run concurrently as one "super simulator." This co-simulation technology lets you attack the problem from as many angles as you like *at the same time;*
- Brings together all the models you need for fast, accurate system simulation, including Verilog HDL, HSPICE, Zycad, VantageSpreadsheet, VHDL, LMC, and others.

The benefits are clear

Best of all, SimBus lets you simulate at *any* point in the design process, using the methodology *you* deem most appropriate.

It also protects your investment in simulators, models, training and — most important — your design data. It can even provide you with a smooth migration path from Verilog HDL to VHDL without jeopardizing your Verilog investment.

If your tools are facing extinction, Viewlogic can help you evolve a whole new world of possibilities. Call today.

To find out about our complete simulation solutions and more, call 1-800-873-8439 today or fax us at (508) 480-0882.

For inquiries outside North America, please call (508) 480-0881; or fax us at (508) 481-3961.

VIEW*logic*®

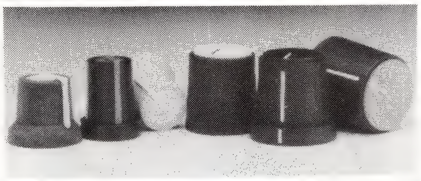
THE REST IS HISTORY

All trademarks and registered trademarks are the property of their respective owners.

READER SERVICE 145

CONTROL KNOBS FEATURE SOFT FEEL

A rubberized design with a soft feel has been added to a line of instrument control knobs. The K87 control knob features a two-shot molded plastic design with a soft-rubber outer body and a hard inner core that comprises the shaft and marker line. This texture, combined with subtle ridges on the knob's body, provide a pleasing and comfortable grip. The knob is suited for all instrumentation applications and is supplied in three push-on sizes for both splined and flatted D shafts. Bodies are black with eight colors to choose from for the marker line. DM



Cliff Electronic Components Inc., 4876 E. Second St., Benicia, CA 94510; (707) 746-8090. **CIRCLE 800**

TURNKEY SERVICE DESIGNS, FABS MCMS

A complete multichip-module (MCM) design service provides design, layout, simulation, fabrication, and test of modules. Targeting commercial and merchant OEMs, the service addresses the concerns of manufacturers hesitant to turn to MCMs because of the significant capital investment they represent. The service offers conversion of applications to MCM implementations and helps with technology decisions on a price-performance basis. Numerous foundry alliances give OEMs access to the MCM process that best meets their needs. Recent projects include high-capacity memory modules, analog mixed-signal processors, an ATM-to-Ethernet interface module, and a DSP module. Call for information. DM

MRC Microelectronics, MCM Design Center, 1720 Randolph Rd. S.E., Albuquerque, NM 87106; (505) 768-7627. **CIRCLE 801**

MULTIMODE CABLES LINK FDDI EQUIPMENT

Pre-terminated fiber-optic cable assemblies for fiber-distributed data interface (FDDI) applications are available for interconnection of data, voice, and video equipment. The fiber within the multi-mode, 62.5-μm cable asssemblies is secured with epoxy to prevent pistoning in the environment in which they're installed. A high degree of precision with respect to mating of fibers is achieved through use of ceramic ferrules instead of metal. A large array of ST, SC, FDDI, SMA, and mini-BNC assemblies is stocked in both standard feet and meter lengths. A test-inspection report included in each cable-assembly shipment guarantees that assemblies fall within the range of 0.5 dB/km loss. Call for pricing and delivery information. DM

Alpha Wire Corp., 711 Lidgerwood Ave., Elizabeth, NJ 07207-0711; Kathleen Peters, (800) 522-5742. **CIRCLE 802**

If you are looking for powerful solutions...

No matter which microprocessor or microcontroller you need to emulate, efficient tools are vital for reducing development time and enhancing software quality.

Hitex knows your debugging requirements like no other company and offers you sophisticated in-circuit emulators operated by a high-performing software debugger.

Quality at attractive prices, reliability, and accurate manufacturing methods, backed up by our technical support and customer service are strengths which characterise us as *the* leader in real-time in-circuit emulation.

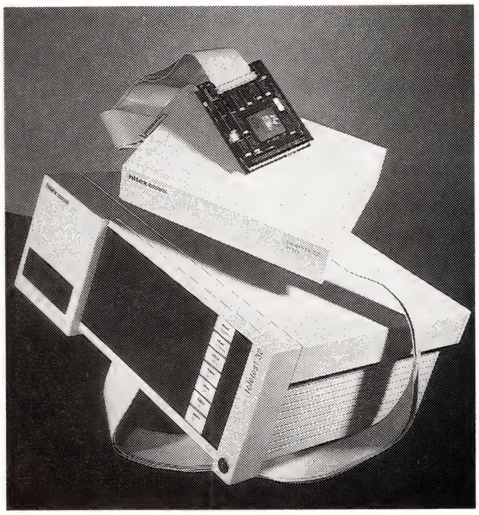
Hitex in-circuit emulators - simply the best

Hitex-Systementwicklung GmbH
Greschbachstr. 12, D-76229 Karlsruhe
☎ (0721) 9628-0 · Fax (0721) 9628-149

Our partners:

A	Walter Rekirsch	☎ (01) 25972700
B	Bytecom S.P.R.L.	☎ (010) 223455
CH	Novitas AG	☎ (01) 9450333
F	Fontaine	☎ (1) 60137517
GB	Hitex (UK) Ltd.	☎ (0203) 692066
I	Insitec Elettronica	☎ (02) 66501075
IL	ITEC Ltd.	☎ (03) 491202
NL	Logic Technology	☎ (04760) 78438
RC	MacSung Industrial	☎ (2) 753-2900
ROK	Moda Technology	☎ (02) 785-3753
S	ESE Sverige AB	☎ (040) 424110

hitex



Hitex emulators are available for:
- all variants of the 8051 family
- 80C165, 80C166, 80C167
- 8086/88, 80C186/188EA/EB/EC/XL
- 80286, 80386DX/SX/CX/EX
- 68K, 6830x, 6833x
- the 68HC11 microcontroller family

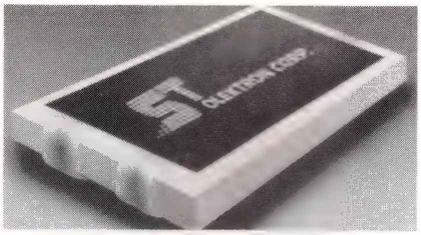
READER SERVICE 195

INCREMENTAL ENCODER ENSURES LONG LIFE

A two-channel rotary incremental encoder for medium-resolution position-sensing applications produces a 2-bit quadrature output signal. The encoder incorporates the company's silver-on-glass technology for a long operating life of 2 million revolutions minimum. Other features include a highly accurate index pulse and internal debounce circuitry. Suited for use as a digital panel control or position-sensing device, the encoder converts rotary motion into electrical signals that can be readily used by microprocessors for control purposes. Applications include robotics, automatic surface-mount-assembly equipment, and precise motion control in devices such as servo motors, stepper motors, and air cylinders. Pricing is less than $13 in lots of 1000. DM

Spectrol Electronics Corp., 4051 Greystone Dr., Ontario, CA 91761; (909) 923-3313. **CIRCLE 803**

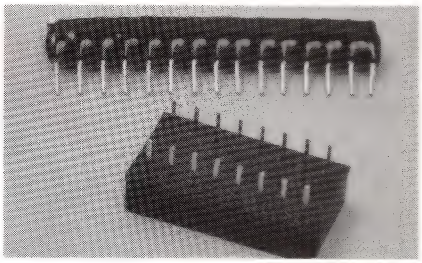
CHIP ATTENUATOR ADJUSTS RF GAIN



The 4100 Series of chip attenuators fills the needs of RF-circuit designers for applications such as tuning and gain adjustment in non-linear circuits, pads for VSWR mismatches, and terminations in feedback systems. Frequency range is from dc to 3 GHz with a VSWR of 1.25:1. Devices are available in standard attenuation values of 3, 6, 10, and 20 dB. The parts' dimensions are 0.126 in. long by 0.063 in. wide by 0.024 in. tall. Pricing is $0.99 each and delivery is from stock. DM

ST Olektron Corp., 28 Tozer Rd., Beverly, MA 01915; (508) 927-9328, ext. 614. **CIRCLE 804**

TVS NETWORKS COME IN SIPS, DIPS



A line of low-cost, low-capacitance SIP and DIP networks provides transient voltage protection for data lines, I/O ports, and ac and dc power-bus circuits. The devices protect any number of unidirectional or bidirectional lines with fast response times and low capacitances of 25 pF. All standard voltages are available from 6.8 to 440 V with peak power to 1500 W. Packaging is on 0.100-in. centers. A eight-line SIP network is priced as low as $1.55 in lots of 1000. DM

Marc Enterprises, 2049 S. Lyon St., Santa Ana, CA 92705; (714) 751-4952. **CIRCLE 805**

"Surely...
we have a better option than **these!**"

Yes, you do.

Turn your
excess inventory
into a tax break and
help send needy
kids to college.

Call for your
free guide to
learn how donating your
slow moving inventory can
mean a generous
TAX WRITE OFF
for your company.

Call (708) 690-0010

EAL

P. O. Box 3021 Glen Ellyn, IL
60138 Fax (708) 690-0565

Excess inventory today....student opportunity tomorrow

Sports An Airbag And ABS, Jumps Thru Hoops At 5 Mips, And Must Launch By The All-Star Match.

Now Design It.™

Oh boy. Another full-court press from our pals in marketing. The design challenge: ultra-fast execution speeds and more functionality ...all in time for the February tip-off. That's where Microchip's PIC16CXX family of mid-range, field-programmable microcontrollers jumps in. Racing along at up to 5 MIPS, these fully loaded 8-bit RISC devices combine price and performance not available in any 80C51 architecture, and OTP design flexibility to match the pace of the marketplace. Code conversions from other MCUs? A slam dunk with a C compiler. And the PIC16CXX family is upward compatible with Microchip's popular PIC16C5X family for a seamless migration path. All this backed by the best support and development tools in the industry. It's simply the lowest cost, highest performance mid-range 8-bit OTP solution available. So get a jump on the competition. Ask for the Basketball Buddy™ Design Kit. Then Design It.

44-62-885-1077

PIC16C5X	I/O	MEMORY PROGRAM	MEMORY USER RAM	FEATURES
PIC1				
PIC1				
PIC1				
PIC1				

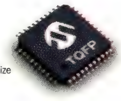
PIC17CXX	I/O	MEMORY PROGRAM	MEMORY USER RAM	FEATURES
PIC1				
PIC1				
PIC1				
PIC1				

PIC16CXX	I/O	MEMORY PROGRAM	MEMORY USER RAM	FEATURES
PIC16C64	33	2K words	128 bytes	SPI, I²C, PWM
PIC16C71	13	1K words	36 bytes	ADC
PIC16C74	33	4K words	192 bytes	ADC, USART, PWM
PIC16C84	13	1K words	36 bytes	EEPROM

MICROCHIP

The Embedded Control Solutions Company™

Microcontrollers • Non-Volatile Memories • ASS


Actual Size

Arizona Microchip Technology Ltd. • Europe • North America • Asia/Pacific • Japan
Unit 6, The Courtyard • Meadowbank, Furlong Road • Bourne End, Buckinghamshire, SL8 5AJ • 44-62-885-1077

The Microchip logo and name and all other trademarked names are trademarks of Microchip Technology Inc. PIC is a registered trademark of Microchip Technology Inc. in the USA. Information subject to change. © 1994 Microchip Technology Inc. All rights reserved. Windows is a trademark of Microsoft Corporation.

READER SERVICE 110

MIL-S-83731 QPL SWITCHES

C&K

Meeting the Challenge!

C&K has always been driven by customer satisfaction. We offer the most complete line of miniature and subminiature electromechanical switches in the world. More choices. More options. More attention to your needs. Our Custom Product Development Group will even design and build the application-specific switch that meets your exact requirements.

Our ultra-modern manufacturing facilities continue to expand, while production techniques and inventory control keep pace to assure you of the best price and fastest delivery. These are all important issues when considering vendor reduction, and C&K is Meeting the Challenge! For a sample and our new catalog, Call (800) 635-5936 or Fax (617) 926-6846.

C&K® COMPONENTS, INC.
Newton Division
(800) 635-5936

C&K® COMPONENTS, INC.
Clayton / Unimax Division
(800) 334-7729

See us at Wescon/94 Booth #2328-2332

Manufactured in the USA: MA, NC; and Worldwide: Hong Kong, England, Costa Rica

READER SERVICE 85

Low Noise
OCXOs

- ☐ Compact package
- ☐ Fast warm-up
- ☐ Ultra-stable
- ☐ Low aging
- ☐ Vectron reliable

Low Noise OXCOs (4 - 25MHz)

MODEL	CO-717L2	CO-718SL2
Aging	1 x10^{-9}/day 3 x10^{-7}/yr	5 x10^{-10}/day 1 x10^{-7}/yr 2-5x10^{-8}/yr opt.
0°C to 50°C -20°C to + 70°C	±1 x10^{-8} ±3 x10^{-8}	±5 x10^{-9} ±1 x10^{-8}
Phase 100Hz Noise 1kHz (4-12MHz) 50kHz	-145dBc/Hz -160dBc/Hz -165dBc/Hz	-155dBc/Hz -163dBc/Hz -168dBc/Hz
Size	2"x2"x1"*	2"x2"x1"*

*3/4" height optional

Low Noise OCXOs (25 - 200MHz)

TYPE	CO-724SL2	CO-725SL2
Aging	2 x10^{-9}/day 5 x10^{-7}/yr	5 x10^{-10}/day 1 x10^{-7}/yr
0°C to 50°C -20°C to + 70°C	±5X10^{-9} ±1X10^{-8}	±5 x10^{-9} ±1 x10^{-8}
Phase 100Hz Noise 1kHz (75-125 MHz) 50kHz	-130dBc/Hz -145dBc/Hz -157dBc/Hz	-120dBc/Hz -135dBc/Hz -140dBc/Hz
Size	2"x2"x1"*	2"x2"x1¼"

*Reduced height available

To order a Free catalog, or for complete engineering assistance, call:
(203) 853-4433
Fax: (203) 849-1423

VECTRON

The Crystal Oscillator Company

VECTRON LABORATORIES, INC.
P.O. Box 5160. Norwalk, CT 06856-5160.

A DOVER TECHNOLOGIES COMPANY

READER SERVICE 143

NEW PRODUCTS

COMPONENTS

BRIGHT PLASMA DISPLAY HAS 128 BY 32 PIXELS

Amusement and gaming machines, industrial controls, and information kiosks are among the applications for the APD-128G032, a 128-by-32-pixel plasma display. Because it produces high brightness (50 fL minimum) with easy-to-read characters and graphics, the device is suited for cost-sensitive display applications requiring excellent viewing characteristics. A 12.75-by-3.15-in. viewing area is combined with a slim profile of less than 0.75 in. Data is presented to the display by means of a TTL-level CRT-type interface. Options include an ASCII-interface controller and dc-dc converter. Pricing is $135 in lots of 100 with delivery from stock to four weeks. DM

Dale Electronics Inc., 1122 23rd St., Columbus, NE 68601-3647; Keith Raysby, (402) 563-6413. **CIRCLE 806**

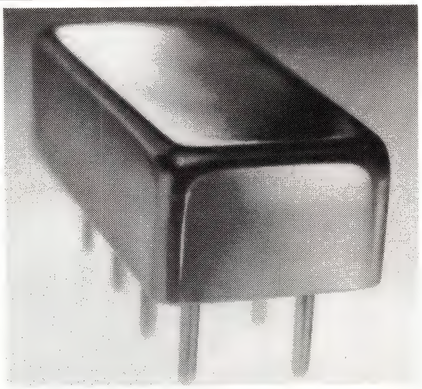
CERAMIC CRYSTALS SUIT PCMCIA PRODUCTS

Some of the smallest surface-mount crystals available today are part of the CX Series, with heights ranging from 1.3 to 1.7 mm. The devices are suited for severely height-restricted applications such as PCMCIA cards. They're available in a broad frequency range from 9.830 to 100.000 MHz and can be specified with either the wider industrial operating-temperature range or the standard commercial range. Pricing in lots of 1000 ranges from $1.45 to $3 depending on frequency, with tape-and-reel packaging standard for orders or 1000 pieces or more. DM

Cardinal Components Inc., 22 S. Park St., Montclair, NJ 07042; Caroline Bartlett, (201) 746-0333. **CIRCLE 807**

TWO-WAY 90° SPLITTER KEEPS POWER IN PHASE

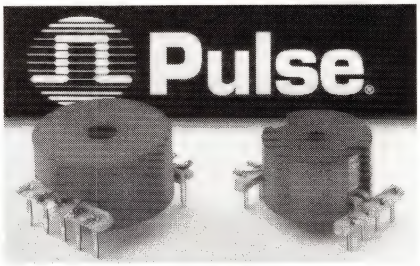
The model PQW-2-90 two-way, 90° power splitter is a wide-band, plug-in unit that operates over the frequency range of 30 to 90 MHz (3:1). It typically offers high isolation of 27 dB, a low 1.1:1 VSWR, and good amplitude (0.6 dB typical) and phase unbalance (1.0° typical) over the entire band. The unit is built for reliable operation from –55 to 100°C and is suitable for use in various signal-processing applications. Pricing is $24.95 in lots of 10 to 49 with delivery from stock. DM



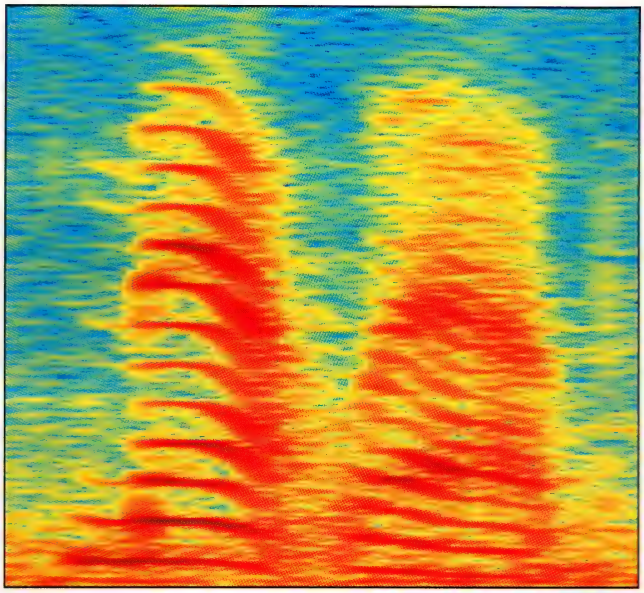
Mini-Circuits, P.O. Box 350166, Brooklyn, NY 11235-0003; (718) 934-4500. **CIRCLE 808**

TRANSFORMERS SUIT ISDN BRI U-INTERFACES

A series of transformers is available for applications in ISDN BRi U-interfaces with 2BIQ coding. The units are matched to the ISDN U-interface transceiver devices from manufacturers such as Motorola, National Semiconductor, SGS-Thomson, and Siemens. These transformers are a critical element for compliance with the requirements of the relevant ANSI and ETSI standards for the various loop lengths. For that purpose, the transformers achieve high linearity and accommodate a dc current of 60 mA or more. Their low profile of 0.450 in. suits them for use in systems with tight spacing between line cards. Pricing is $3.80 in lots of 250. Delivery is from stock. DM



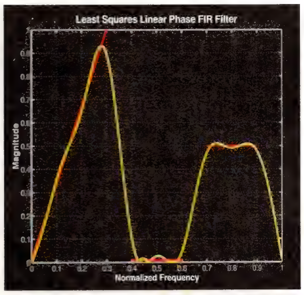
Pulse Engineering Inc., P.O. Box 12235, San Diego, CA 92112; (619) 674-8100. **CIRCLE 809**



MATLAB simplifies analysis and algorithm development with integrated modeling, design and graphical tools. This spectrogram shows how a speech signal varies with time and frequency.

Speak the language of signal processing with MATLAB®

The MATLAB Signal Processing Toolbox is a powerful interactive environment for signal analysis, algorithm development, and DSP design.



Leading-edge filter design tools make it easy to design filters to fit any specification.

Because its matrix language is ideal for vector processing and data analysis, MATLAB helps you solve the widest range of signal processing problems.

Signal processing power

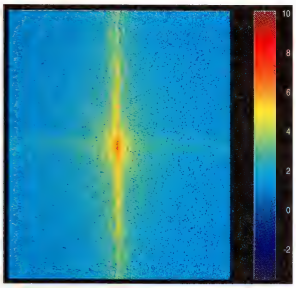
The Signal Processing Toolbox gives you an unrivaled ability to filter, model, and analyze signals and time-series data. Powerful functions let you perform FFTs, spectral estimation, and filter design in a single step, and display the results automatically. Without writing a single line of C or Fortran, you can easily explore, create, and apply the innovative signal processing tools that let you keep up with—and advance—the leading edge.

Rapid algorithm development

You create DSP algorithms in MATLAB just as you would write them mathematically. As a result, you can rapidly validate your designs long before you commit to a full implementation.

Your work always draws upon world-class tools, whether you rely on classical methods or invent state-of-the art technology.

MATLAB brings a foundation of over 500 math, scientific, and engineering functions to your desktop. Each function is tuned for maximum efficiency and numeric reliability. So you always get immediate, accurate results.



Visualization of a 2-D FFT. Efficient FFT algorithms form the basis for powerful spectral analysis and estimation functions.

Expand your DSP vocabulary

With the high-level MATLAB language, it's easy to modify the source code for any toolbox function, and add your own. Or combine signal processing with other toolboxes to design custom solutions to complex problems.

Powerful GUI tools let you build intuitive applications that look like pre-packaged software, but address your specific design and analysis needs.

MATLAB®
Picture the Power

Signal Processing Toolbox

- ***Complete tools for filter design, analysis, and implementation***
- ***FFT, DCT, cepstrum, chirp-z, Hilbert, and other transforms***
- ***Spectrum estimation and statistical signal processing***
- ***Signal and linear system models***
- ***Specialized design tools for embedded real-time, multi-rate, and communications systems***
- ***Integrated with application toolboxes, including:***
  - ***Image Processing***
  - ***System Identification***
  - ***Hi-Spec™***
  - ***Neural Networks***
  - ***Optimization***

The Ultimate Technical Computing Environment™

MATLAB is an extensible, interactive Technical Computing Environment that seamlessly integrates computation, visualization, and modeling, on PCs, workstations, and supercomputers. You will find it wherever people speak the language of signal processing.

For a free technical brief that will show you the signal processing power of MATLAB, call us today.

508-653-1415

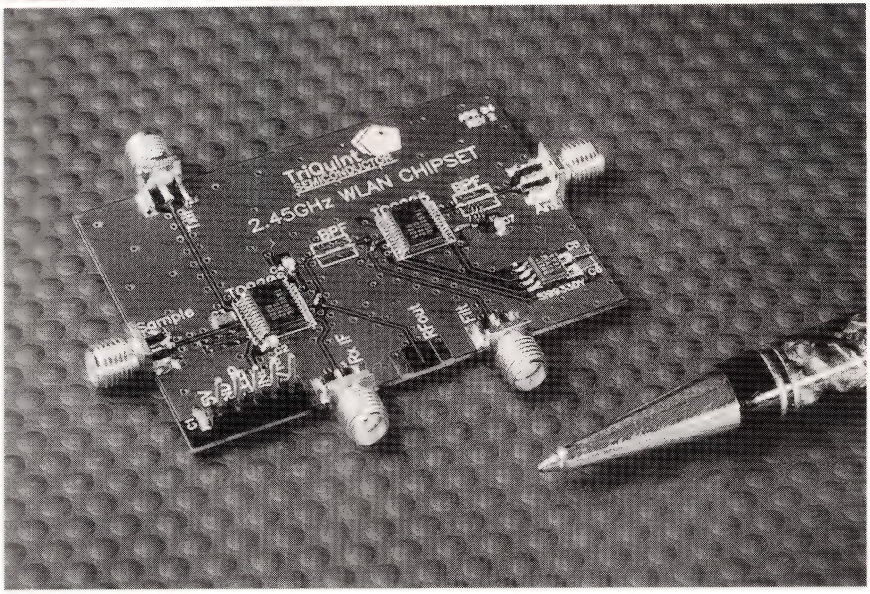
The MATH WORKS Inc.

24 Prime Park Way/ Natick, MA 01760
Tel: 508/653-1415 Fax: 508/653-6284
Email: info@mathworks.com
Mosaic: http://www.mathworks.com

The MathWorks is represented in the following countries:
Australia: +61-2-922-6311 • Brazil: +55-11-816-3144
France: +33-1-45-34-23-91 • Germany: +49-241-26041
India: +91-80-2-260-260 • Israel: +972-3-561-5151
Italy: +39-11-24-85-332 • Japan: +81-3-5978-5410
Portugal: +34-3-415-49-04 • Scandinavia: +46-8-15-30-22
Spain: +34-3-415-49-04 • South Korea: +82-2-517-1257
Switzerland: +41-31-998-44-11 • Taiwan: +886-2-501-8787
For Belgium, Luxembourg, The Netherlands, United Kingdom and Republic of Ireland call Cambridge Control, Ltd: +44-223-423-200 **or** Rapid Data, Ltd: +44-903-821-266

MATLAB is a registered trademark of The MathWorks, Inc.

TWO-CHIP 2.4-GHZ TRANSCEIVER RAISES PERFORMANCE, DROPS COST OF WIRELESS PRODUCTS



A highly integrated, low-cost 2.4-GHz transceiver chip set promises to simplify the design of many wireless products, while also reducing their size and power requirements. Aimed at applications—such as wireless LANs, remote data-entry systems, wireless PBXs, and mobile transaction terminals—the two-chip set consists of the TQ9205 amplifier/switch front end and the TQ9206 RF up/down converter.

Manufactured by TriQuint Semiconductor, Beaverton, Ore., the devices feature a high degree of integration. By minimizing component count, the chip set enables designers to reduce design time and manufacturing costs, and allows their products to meet the tight space constraints of today's portable products. Both parts are fabricated using TriQuint's proven Gallium Arsenide (GaAs) production technology. This high-volume process allows customers to enjoy GaAs's superior low-noise and high-frequency characteristics at the price of comparable silicon devices. Special attention was also paid to the power efficiency of the devices and incorporation of power conservation functions, a necessity compact, battery-powered applications.

Under any circumstances, RF design can be tricky, but when the space constraints of a portable unit are introduced, problems can multiply. As part its effort to assist design engineers with the task of evaluating and integrating its parts, TriQuint is offering a pre-engineered transceiver in the form of an evaluation kit.

The kit includes a ready-to-solder pc board, two chip sets, and all passive components required to build a fully operational transceiver subsystem. Also included with the development kit are a full set of data sheets and application notes. A CAD data file of the pc-board layout is also provided with the kit. Having a proven baseline circuit design should help engineers greatly accelerate their product-development efforts.

The TQ9205 amplifier/switch contains two amplifiers and a pair of fully integrated receive and transmit SPDT switches. Both switches are configured to allow half-duplex operation at the antenna and filter ports. In the receive path, the chip matched low-noise amplifier is capable of directly driving the RF filter, while delivering a 3.5-dBm noise figure. The transmit path includes a medium-power (100-mW) RF amplifier with a 13-dB power/gain figure (typical).

Operating from a single 5-V supply, the chip's receiver typically draws 33 mA, while the transmitter pulls 210 mA in its operating mode. The amplifier's 23-dBm (typical) power output and the 14-dBm third-order intercept point provide for maximum dynamic range with minimum distortion.

The TQ9206 integrated RF up/down converter contains mixers, buffers, and an on-chip VCO capable of tuning across the entire 2.4- to 2.483-MHz ISM (industrial, scientific, and medical) frequency band. On-chip output buffering enables the chip to be directly connected to the divider input of a PLL synthesizer. The TQ9206's receiver conversion gain is –1 dB, with a third-order intercept point at +14 dBm (typical). Power consumption has been held to just 30 mA in receive mode, and 80 mA while it is transmitting.

Because the chip set's primary market lies in portable, battery-based applications, special attention was paid to keeping power consumption to a minimum without sacrificing performance. Power management is accomplished for both chips via CMOS logic-compatible control lines.

Both the TQ9205 and TQ9206 chip's Tx/Rx mode-select logic is designed to stretch available power by automatically turning off the electronics in the unselected signal path. The same logic permits both chips to be placed into a power-down mode when neither transmit or receive functions are being used.

Packaged in PCMCIA-compatible 24-pin SSOPs, both devices are available in production quantities. In lots of 10,000, the TQ9205 amplifier/switch is priced at $9.77, while the TQ9206 up/down converter goes for $10.42.

The evaluation board is available for $75.00 and comes complete with all components, two each of the TQ9205 and TQ9206 chips, plus data sheets, application notes, and CAD-layout information.

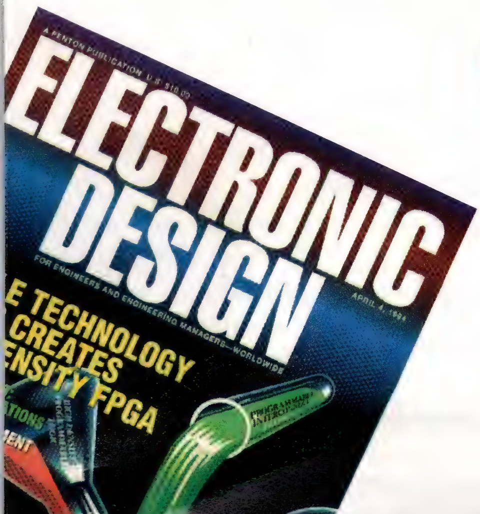
TriQuint Semiconductor Corp., *3625A S.W. Murray Blvd., Beaverton, OR 97005; Joe Skovron, (503) 644-3535.* **CIRCLE 810**

■ *LEE GOLDBERG*

Received,
Read,
Shared,
Analyzed,
Scrutinized,
Challenged,
Archived,
and Appreciated

Over 165,000 readers can't be wrong

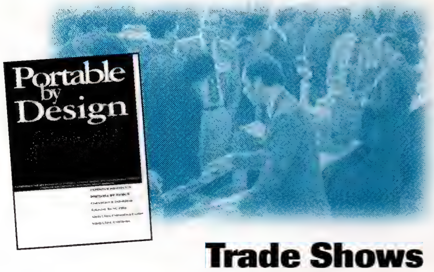
26 regular issues,
7 special supplements,
1 trade show,
TeleBase™ info service,
5 years on CD-ROM



ELECTRONIC DESIGN

A PENTON PUBLICATION

To subscribe or to receive additional information call: 201-393-6060



Trade Shows

Portable by Design focuses on OEM designers of portable, nomadic, mobile, and transportable products.

● ● ● ● ● ● ● ●

5 Years on CD-ROM

A complete library on CD. All the articles, photos, drawings, schematics, editorials, and letters - all on one easy-to-use disk.

● ● ● ● ● ● ● ●

TeleBase™ info service

A great new way to source products. The TeleBase Directory has hundreds of categories and is updated monthly.

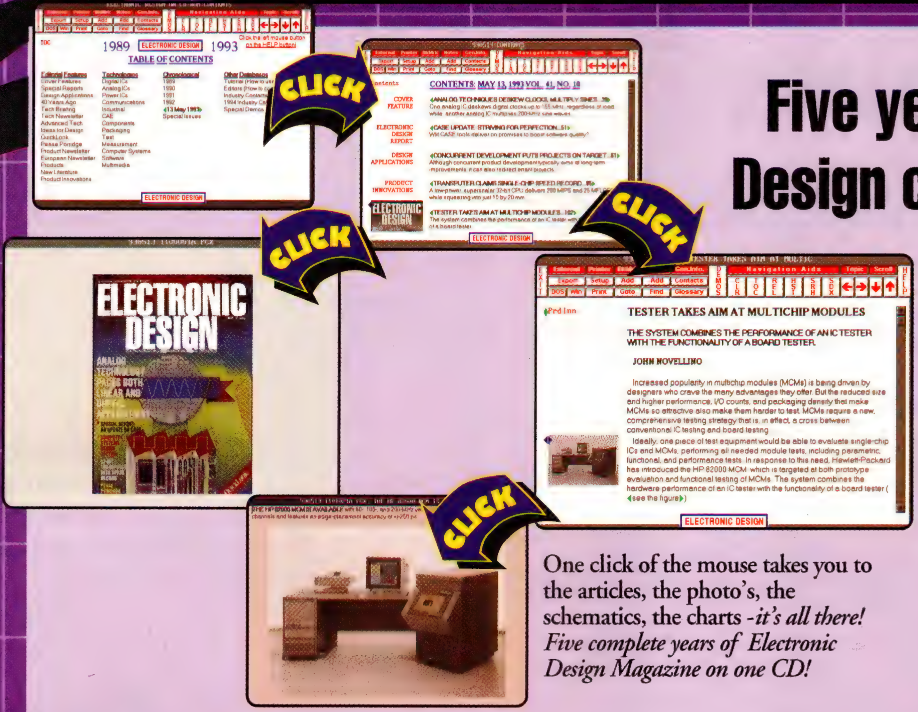
● ● ● ● ● ● ● ●

Special Supplements

Seven supplements released yearly focus extensively on specific topics. Supplements make great reference sources for electronic design professionals.

ELECTRONIC DESIGN: 1989-1993
FIVE YEARS
OF
ELECTRONIC
DESIGN
ON CD-ROM
FOR ENGINEERS AND ENGINEERING MANAGERS
1993
1992
1990
DEMOS
CLICK

COMPLETE 30-DAY MONEYBACK GUARANTEE!
If you're not satisfied after 30 days, send it back and owe nothing!



CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE
ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...39
One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves.

ELECTRONIC DESIGN REPORT
CASE UPDATE: STRIVING FOR PERFECTION...51
Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS
CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...81
Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects.

PRODUCT INNOVATIONS
TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95
A low-power, superscalar 32-bit CPU delivers 200 MIPS and 25 MFLOPS while squeezing into just 10 by 20 mm.

TESTER TAKES AIM AT MULTICHIP MODULES...102
The system combines the performance of an IC tester with the functionality of a board tester.

Prd Inn

TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

Ideally, one piece of test equipment would be able to evaluate single-chip ICs and MCMs, performing all needed module tests, including parametric, functional, and performance tests. In response to this need, Hewlett-Packard has introduced the HP 82000 MCM, which is targeted at both prototype evaluation and functional testing of MCMs. The system combines the hardware performance of an IC tester with the functionality of a board tester (see the figure)

ELECTRONIC DESIGN

Five years of Electronic Design complete on one CD

- *All the articles*
- *All the photographs*
- *All the schematics*
- *All the drawings*
- *All the editorials*
- *All the letters*

One click of the mouse takes you to the articles, the photo's, the schematics, the charts *-it's all there! Five complete years of Electronic Design Magazine on one CD!*

THIS CD-ROM, produced by the Editors of Electronic Design Magazine, contains five complete volumes - that's 124 past issues of Electronic Design Magazine. Presented in 16-color VGA, it's packed with more than 4,000 photos and graphics. All the articles, features, product reviews, product updates *(even product demos!)*, editorials, letters are included - everything electronics industry professionals expect from Electronic Design.

All of the information in this CD is made instantly accessible through a powerful Hypertext application called *Hyperwriter*™.

Hyperwriter™ makes the information on this disk instant accessible through hypertext links. Links made directly throu each topic (article) to pictures, illustrations, schematics, full gl saries, product demos, and contact names, plus past and subs quent related topics.

Specific topics are quickly located using the powerful sear features provided. Using a key-word or key word strings, you g a list of all related topics-*instantly.*

Instant comprehensive information. That's what this disk is about.

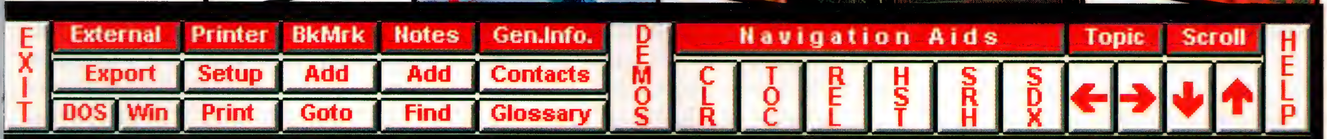
International phone orders call: *201-393-6060* • ***Inside USA:*** *800-829-9028-9am-5pm est.* • ***To order by fax:*** *201-393-0204*
To order by mail: *Send your order to: Electronic Design Magazine, 611 Route 46 West, Hasbrouck Heights, NJ 07604*

5 Years of Electronic Design Magazine on CD-ROM (1989-93)	**$295⁰⁰**	1 Year of Electronic Design Magazine on CD-ROM (1993)	**$95⁰⁰***

Network 1 & 5 year versions also available - call for details

** Upgrade to the 5 year version within 90 days and pay only $2*

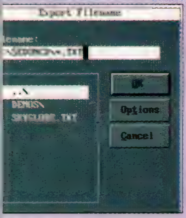
ELECTRONIC DESIGN
32-BIT OS
3D GRAPHIC
HOW CAD/CAE REVENUES SHAPE UP
ELECTRONIC DESIGN
LOAD-SHARING SCHEME BOOSTS
U.S. REVENUES FOR NETWORK MANAGEMENT KEEP CLIMBING



earn the backbone of the Electronic Design Magazine CD-ROM interface - the BUTTONBAR.

owerful, hypertext-based commands let u quickly and efficiently find, re-find, k, make notations, leave bookmarks, port, print, search, get product demos, d even return to your operating system!

ternal - Life beyond this disk



The **Export** button will export any or all of an article based on your selection.

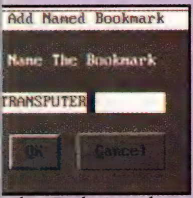
DOS & Win
DOS brings you to the DOS prompt reen and **Win** takes you into Windows™ thout quitting the application. These ittons make it easy for you to return to ectronic Design Magazine, where you left f, without re-launching.

inter Commands

etup & Print - This feature allows u to print articles, editorials, glossries, illustrations, and even photos *(if ur printer is capable)* directly from this D. Great source for reference.

ookmarks and Notes

3kMrk - Bookmarks flag topics for future erence, just like using a bookmark in a real magazine. Mark a spot, and the bookmark is stored even if you quit.

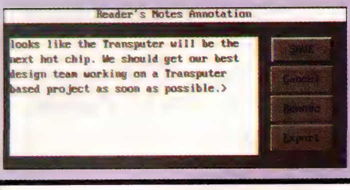

Add Named Bookmark

Name The Bookmark

TRANSPUTER

GOTO brings you back to your bookarks. Deleting them is just as simple.

Notes - Add and find your own notations. otes stay until you delete them, even after u quit.


Reader's Notes Annotation

```
looks like the Transputer will be the
next hot chip. We should get our best
design team working on a Transputer
based project as soon as possible.>
```

Gen. Info - Complete reference

Contacts - Company names, addresses, contact names, phone numbers- all of the information you need to follow up.

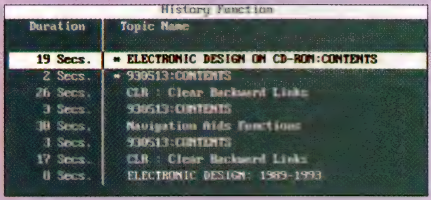
Glossary - Full article glossaries, provided by the Editors of Electronic Design magazine. The CD also comes with **WORD LINK**, which allows you to click on any word within the article and if it's in the glossary, the definition pops up. When you're done, a simple click and it's gone.

Navigation Aids - Magellan you're not, and you don't need to be!

All the aids you'll need to motor your way through this CD in no time flat.

CLR - *Clear Back Links* - Because every article you move to loads into RAM, this function allows you to clear articles you've finished. This frees up RAM for you to continue.

TOC - *Table of Contents* - Takes you directly to the Volume Table of Contents (the whole year) with special links provided to Issue T.O.C.

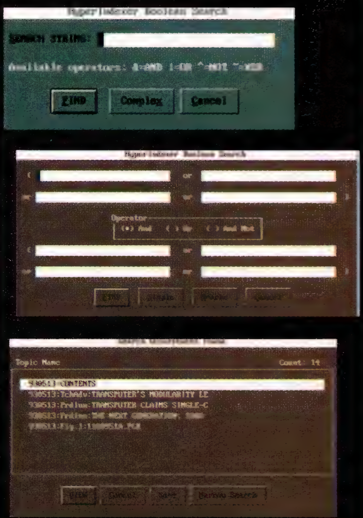

```
                    History Function
  Duration    Topic Name

   19 Secs.   * ELECTRONIC DESIGN ON CD-ROM:CONTENTS
    2 Secs.   * 930513:CONTENTS
   26 Secs.     CLR : Clear Backward Links
    3 Secs.     930513:CONTENTS
   10 Secs.     Navigation Aids Functions
    3 Secs.     930513:CONTENTS
   17 Secs.     CLR : Clear Backward Links
    0 Secs.     ELECTRONIC DESIGN: 1989-1993
```

REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

HST - *Show-Related History* - Shows each topic visited during your current session and how long you were there, and then lets you return to previous topics.

SEARCH dialog boxes

Simple search (top), Complex Search (center), and Search occurances found (bottom).


SEARCH STRING:

Topic Name   Count: 14

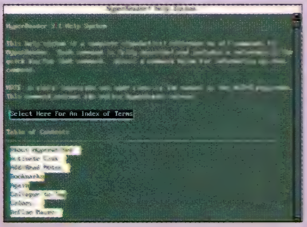
```
930513:CONTENTS
930513:Tchadv:TRANSPUTER'S MODULARITY LE
930513:Prdlun:TRANSPUTER CLAIMS SINGLE-C
```

SRH - *Search* - Conduct simple, complex or proximity indexed searches.

SDX - *Subject Index* - A hierarchical list of key subject areas compiled by the Editors of Electronic Design. The index also allows direct access to related topics.

HELP - Instant on-line help for all

Written in plain, easy to understand terms providing information for novice and pro alike. Available in any user screen.



MINIMUM SYSTEM REQUIREMENTS

- ☞ 80386 PC or better
- ☞ VGA video card adaptor w/640 x 480 pixel resolution 16 colors.
- ☞ 1 meg ram
- ☞ MS-DOS Version 3.1 or later

ORCAD LIBRARIES EASE PCB DESIGN

The Professional Module Libraries are a CAD library resource for engineers using OrCAD's PCB 386+ board design tools. Productivity is increased with the more than 2400 component and socket module patterns, actual size documentation, and descriptive naming conventions. The result is higher search and match rates in on-line or off-line situations. For the quality-control specialist, the libraries provide consistent application of physical standards, drill and pad management, and the use of reference information modules within libraries. Also, these features reduce design cleanup. Of the 2400+ descriptively-named modules, 66% are through-hole and 34% are surface mount. Professional Module Libraries cost $349, and ship within two working days. LM

916 Design, 1200 W. Sacramento Ave., No. 8, Chico, CA 95926; (916) 894-7876. **CIRCLE 811**

SIMULATOR ANALYZES FULL-CHIP POWER

The P-Grid software performs power-network analysis for an entire IC. P-Grid solves fields in 3D for very accurate extraction and simulation of resistance parasitics, voltage densities, and current densities. The software is fast—engineers can simulate an average IC-block power net (solving more than 50 million discretized equations) in a few hours on a workstation platform. Key product features include: automatic translation of 2D layout data to 3D models, automatic or specific voltage definition, and block or specific current-source definition. In addition, the tool displays a color-coded view of voltage- and current-density distributions. P-Grid runs on Unix-based workstations. It's shipping now, and costs $75,000. LM

OEA International Inc., 3235 Kifer Rd., Suite 300, Santa Clara, CA 95051; (408) 738-5972. **CIRCLE 812**

SIGNAL-INTEGRITY TOOLS RUN UNDER WINDOWS

The electromagnetics-based signal-integrity design and analysis tools from Ansoft now run on a PC under Windows. These tools are Maxwell SI Eminence, SI Spicelink, and SI Extractor. The full range of capabilities previously offered by the Unix versions of the products is available on PCs running Windows 3.1 and Windows NT operating systems. All together, these products offer an integrated solution to the full spectrum of high-speed design issues faced by engineers, from signal-delay analysis through electromagnetic compatibility. Personal-computer versions of the products are shipping now. Call the company for pricing and additional information. LM

Ansoft Corp., Four Station Sq., Suite 660, Pittsburgh, PA 15219-1119; (412) 261-3200. **CIRCLE 813**

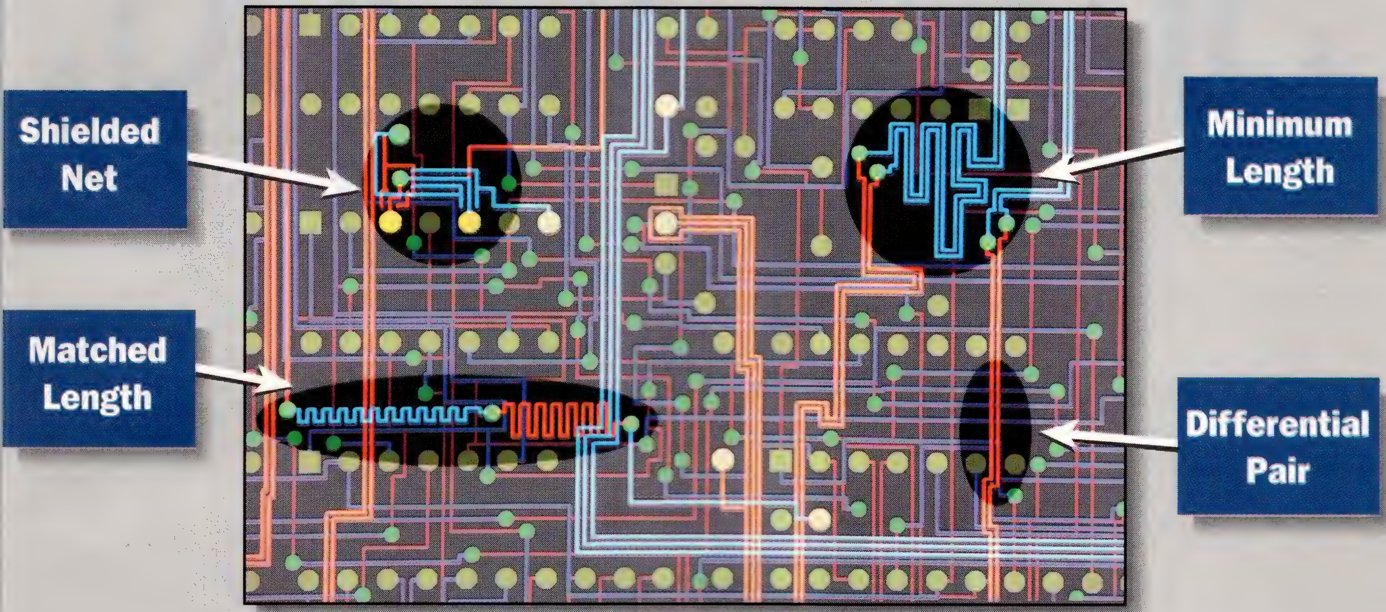
DESIGN-DATA VERIFIER REDUCES ECO COSTS

It's easier to make changes at any stage of the design cycle with the EDAvalidator family of software for design-data verification. EDAvalidator interfaces with and complements the traditional EDA tool suites, providing for verification and resynchronization of design data throughout the design and manufacture process. This ensure proper ECO and revision control between different versions and departments in both single- and multi-vendor environments. The software identifies database differences created during the design process. It also lets users selectively or globally update the different design representations, and synchronize the databases. Connectivity and annotated property information such as component placement are checked and compared. By establishing appropriate syntax mapping rules, EDAvalidator provides an intelligent compare that ignores syntactic differences in checking for equivalency. EDAvalidator runs on Unix workstations, and is available in several configurations. Pricing starts at $15,000. LM

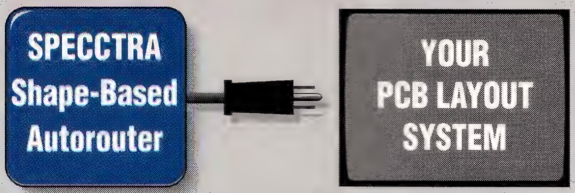
Harris EDA Inc., 7796 Victor-Mendon Rd., P.O. Box H, Fishers, NY 14453; (716) 924-9303. **CIRCLE 814**

MicroGrid® Precision-Expanded Metal Foil
Highly engineered characteristics. Up to 95% open area. In most metals.
Call for a free sample.
DELKER CORPORATION
16 Commercial St., PO Box 427, Branford, CT 06405 203/481-4277 FAX: 203/488-6902

CCT Specializes In Autorouters For Fast Circuits



Compare Cooper & Chyan's fast circuit autorouters to the competition. Only SPECCTRA Shape-Based autorouters consistently complete dense, SMD layouts while obeying high-speed electrical rules. See how SPECCTRA's unique capabilities save you time and money in autorouting your most demanding PCBs.



SPECCTRA plugs into your PCB layout process with no change to your PCB CAD system. Call today for a free demo disk and information regarding a free benchmark.

1-800-759-9767

COOPER & CHYAN TECHNOLOGY, INC.

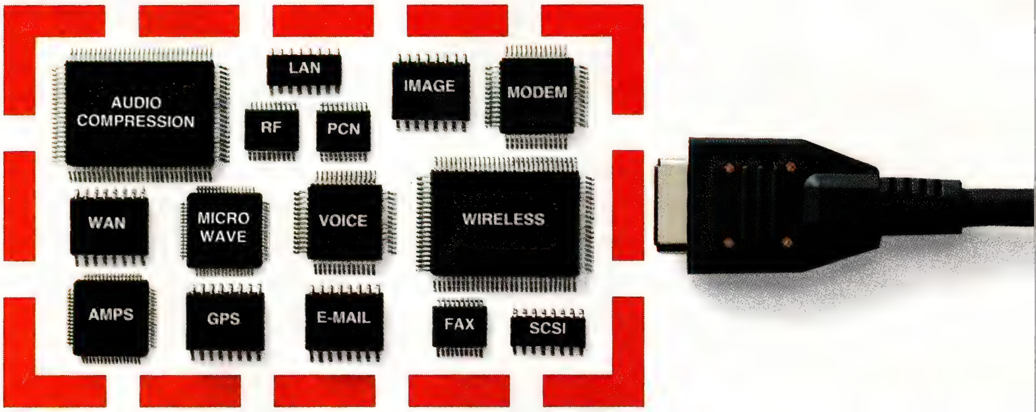
In North America:
1601 Saratoga-Sunnyvale Road, Suite 255
Cupertino, California 95014 USA
Tel: (408) 366-6966
Fax: (408) 252-9565

In Europe:
Erhardtstrasse 8
80469 München
Tel: 49-89-202 1000
Fax: 49-89-202 1001

READER SERVICE 87

Communications ICs

Small world, isn't it?



Goodbye electronic cottage. Say hello to a communications world in which users will roam free like nomads, yet remain as interconnected as if they were still hard-wired to their desks.

Silicon Systems is the one mixed-signal integrated circuits (MSICs®) company now involved in all facets of this smaller, yet highly evolved, state of portable communications: WAN digital transmission, LANs, modems and wireless communications.

Partnering with farsighted design engineers like you, we're developing low-power, high-performance and small-footprint communications ICs for motherboard, daughterboard, and PCMCIA card integration. For wide area network digital transmission. For wire line and wireless modems with data/fax capability. For portable LANs. And for high-frequency wireless applications as well as a wide range of other portable systems.

In this small world your next big idea becomes all the more achievable when you take advantage of our custom MSICs product expertise. Our design centers in North America and Asia. And our comprehensive CMOS, Bipolar and BiCMOS fab process capabilities. Join us. Call us for our Communications **Tool Kit Brochure**, and if you'd like, we'll tell you how to contact your nearest Silicon Systems representative.

1-800-624-8999, ext. 151.

Silicon Systems, Inc.
Communications/Industrial Products Division
14351 Myford Road, Tustin, CA 92680
Ph (714) 573-6000 Fax (714) 573-6906
European Hdq. U.K. Ph (44) 81-443-7061
Fax (44) 81-443-7022

silicon systems®
A TDK Group Company

READER SERVICE 154

ANALYSIS LOOKS AT MIXED-SIMULATION DATA

Signalscan 3.0 is an analysis tool that lets engineers view signals from mixed simulator environments. It supports data from Cadence's Verilog products, Chronologic's VCS, Fintronic's FinSim, Simucad's Silos, Epic's TimeMill and PowerMill, and Meta Software's HSpice. The tool has viewing capabilities for both analog and digital simulation. And to shorten design time, users can mix and match signals from different simulators, and analyze the results simultaneously with one common interface. Signalscan 3.0 provides backward tracing from signals to drivers, regression and statistical testing support, and an interactive signal display. A key component of the Signalscan tool is the proprietary SST file format that accesses data very quickly. For example, signals can be loaded from a typical 100-Mbyte SST file is just 3 sec. Signalscan 3.0 runs on Windows- and Unix-based platforms. It's available now for $4995. LM

Design Acceleration Inc., 2105 Hamilton Ave., Suite 370, San Jose, CA 95125; (408) 559-8500. **CIRCLE 815**

VHDL EDITOR MANAGES TOP-DOWN DESIGNS

Insight HDL is a VHDL design-specification and -management tool from Summit Design that controls the top-down design of ICs and systems. The high-end VHDL editor is based on the technology and object-oriented development environment first seen in the company's Xpert HDL tool. Insight HDL expands the Xpert HDL features for editing, syntax checking, synthesis-rule checking, and design management to include intuitive VHDL configuration-management capabilities. Insight HDL turns the task of creating VHDL configurations into a point-and-click operation. Engineers can view VHDL models through an abstract graphical metaphor. The tool converts text descriptions into tree-based graphical representations. Insight HDL costs $11,000. LM

Summit Design Inc., 9305 S.W. Gemini Dr., Beaverton, OR 97005; (503) 643-9281. **CIRCLE 816**

TIMING-DRIVEN SOFTWARE PERFORMS IC PLACEMENT

The HyperPlace placement software helps create channel-based, sea-of-cells standard-cell, and gate-array ICs. A timing-driven mode lets users input critical-path timing constraints in the Standard Delay Format (SDF) so that HyperPlace can minimize wire length by placing cells connected to these paths closer together. HyperPlace's concurrent algorithmic approach and efficient data model mean that even large deep-submicron designs can be placed without problems. Integration with an independent design planner lets layout engineers do floorplanning and final placement together. They can then choose one of many supported routing engines to finish the job. HyperPlace, which is shipping now, runs on Unix workstations. Pricing starts at $30,000. LM

High Level Design Systems, 3945 Freedom Circle, Fourth Floor, Santa Clara, CA 95054; (408) 748-3456. **CIRCLE 817**

WINDOWS-BASED FPGA TOOLS SUPPORT VHDL

VHDL is now an option for users of Synario 2.0, the latest version of Data I/O's universal FPGA design system that runs under Windows. The VHDL option lets engineers enter, simulate, and synthesize FPGA and CPLD designs using the IEEE-standard language. Synario integrates synthesis of VHDL descriptions with device-specific synthesis capabilities for implementation of logic diagrams in programmable ICs. Simulation is performed with a VHDL functional and timing simulator from Model Technology, Beaverton, Ore. The Project Navigator, an intelligent design-management tool, provides a checklist of processing steps. Topdown Design Solutions, Nashua, N.H., provides a range of educational support, including on-site training and a VHDL self-starter kit for Synario users. Synario 2.0 is available for $2995. The VHDL environment is purchased as an option for $4995. LM

Data I/O Corp., 10525 Willows Rd. N.E., P.O. Box 97046; Redmond, WA 98073-9746; (800) 332-8246 or (206) 881-6444. **CIRCLE 818**

Accessories for rf testing

PCB emissions scanner • Locates low-to-high emissions, displays color image, stores data for design corrections at development stage.

Dual-directional couplers • Seven models up to 15 kW, matched to AR amplifiers and antennas.

Ultra-broadband E-field monitor • Four-channel capability, 1 to 300 V/m, isotropic probes cover 10 kHz to 1000 MHz or 80 MHz to 40 GHz.

Broadband fiberoptic data links • Modular plug-in analog systems for acquiring and measuring interference data, stimulating EUT, displaying results in color or monochrome, 10 kHz to 1 GHz.

Fiberoptic CCTV systems • Watch performance of EUT under hostile EMI and/or EMP shielded-room conditions, in color or monochrome.

TEM cells • Half again the bandwidth of comparable-size chambers: To 750 MHz for 15-cm EUT, 375 MHz for 30-cm EUT.

Computer bus interfaces • Two models, for isolated GPIB connection or isolated TTL connection, permit remote operation of amplifiers.

RF connection kit • Things you'd search for around the lab: Cables, coax adapters, connectors, fuses, lamps, fabricated cables.

Power combiner/dividers • Combine signals from four amplifiers, or divide one signal into four outputs.

High-power rf matching transformers • Match 50-ohm input to 12.5- or 200-ohm output. Up to 2 kW cw.

Call toll-free (**1-800-933-8181**), and one of our applications engineers will answer the phone.

ar AMPLIFIER RESEARCH

160 School House Road,
Souderton, PA 18964-9990 USA • Fax 215-723-5688
**In Europe, call EMV: Munich, 89-612-8054;
London, 908-566-556; Paris, 1-64-61-63-29.** 6312

CIRCLE 241

ADD SERIAL I/O TO PC PROGRAMS

The Software Wedge adds two-way serial I/O capabilities to DOS, Windows, OS/2, or NT applications. As a result, the software can interface to PC programs such devices like electronic scales, lab instruments, barcode readers, and other data collection instruments. The professional versions include the ability to parse and filter incoming data as well as add in additional keystrokes or date/time stamps. As a consequence, users have control how and where data appears in other application programs. Other features include timed automatic output strings, hot-key activated output strings, input data translation tables, and support for 16550 UARTs. The DOS and Windows versions of the Software Wedge include serial diagnostic utilities for debugging communication problems. A professional DOS edition is $295; a Windows version is $395. The standard edition is $199 for Windows, $129 for DOS. SVT

T.A.L. Enterprises, 2022 Wallace St., Philadelphia, PA 19130; (215) 763-2620 or (800) 722-6004. **CIRCLE 819**

PROJECT MANAGEMENT SERVER DEBUTS

MPS1 is a multi-project management server, which ties together multiple users and goes beyond project planning, offering a project-management-process. The program maintains multi-project databases and plans, tracks, and updates project schedules, providing ticklers. It tracks and communicates dependency status. The software also resolves interproject conflicts. It reallocates resources based on interproject priorities. The software also offers e-mail capabilities. Pricing for the Windows 3.1 version is $995/server and 10 clients; the Unix workstation version goes for $2995 for a server and 10 clients. SVT

ProjectWare Inc., 1524 Condor Way, Sunnyvale, CA 94087; (408) 773-8237. **CIRCLE 820**

PROGRAM MONITORS NET SOFTWARE USE

SoftWatch is a software tool that enables end users to get consolidated usage reports on software applications and to monitor and control networked software usage. With the software, companies can monitor daily, weekly, and monthly use of software by individuals, groups, or machines and report on this use. The reports enable the company to assess whether its current software configuration is adequate for the needs of its users. SoftWatch works with any off-the-shelf Unix application. Prices start at $495 on a per-ten client basis. SVT

Elan Computer Group Inc., 888 Villa St., 3rd Floor, Mountain View, CA 94041; (415) 964-2200; fax -8588. **CIRCLE 821**

RUBIDIUM FREQUENCY STANDARD
MODEL FE-5650A
FREQUENCY ELECTRONICS, INC.
55 CHARLES LINDBERGH BLVD.
MITCHEL FIELD, N.Y. 11553
0
1
2
3

Timing Is Everything.

EXCEPTIONAL STABILITY with LOW PRICE makes our Model FE-5650 Commercial Rubidum Atomic Standard the perfect Cost Effective replacement for precision quartz oscillators in communications and timing systems.

Frequency Electronics' FE-5650 rubidium atomic standard is the smallest commercial atomic standard now available, only 3"x3"x1.4". It consistently provides high-quality performance over a wide range of applications and environmental conditions. Additional features include power consumption of <7.5 watts • warm-up time of <4 minutes • low phase noise • outstanding accuracy • low spurious • excellent harmonics • factory settings at any frequency from 10 kHz to 20 MHz, with a setting resolution of 2×10^{-12}.

Call Or Write Today For Complete Specifications.

FREQUENCY ELECTRONICS, INC.
55 Charles Lindbergh Blvd., Mitchel Field, NY 11553
516-794-4500 • FAX: 516-794-4340

READER SERVICE 188

ABSOLUTE VALUE

Iigh performance LCR meters from SRS. Absolutely lowest price. Starting at **$1295**.

alue. It means getting your money's worth.

or passive component measurement, the new andards in value are the SR720/715 LCR ieters from SRS. Meters that offer significant dvantages in performance and price. erformance like .05% basic accuracy, 100 kHz st frequency, and fast measurement rates up 20 per second. Features like a built in Kelvin ture, averaging, binning and limits, stored etups, and quick calibration. With the standard S232 and optional GPIB and Handler interfac-s, the SR720/715 solves your incoming spection and automated test needs. All for a ice well below what you'd expect.

he SR720/SR715. Absolute values in a com-ex world. Call **(408)744-9040** today for more formation about the SRS advantage.

SR720 **$1995**

- 0.05% basic accuracy
- 100 Hz to 100 kHz measurement frequency
- Two 5 digit displays for simultaneous readout of major and minor parameters.
- Auto, R+Q, L+Q, C+D, C+R, Series and Parallel measurement modes
- 100 mV to 1.0 V test signals
- Internal and External Bias
- Binning and Limits for production testing and component inspection.
- RS232 interface
- GPIB and Handler interface (optional)

SR715 **$1295**

Same as SR720 except:
- 0.2% basic accuracy
- 100 Hz to 10 kHz measurement frequency

SRS **STANFORD RESEARCH SYSTEMS**

1290 D Reamwood Avenue, Sunnyvale, CA 94089 TEL (408)744-9040 FAX 4087449049

READER SERVICE 133

LORIN

coil-anodized aluminum for Electronics

Higher quality, **lower** cost than stainles

concept phase concept phase concept phase concept
development under development under development
in production in production in production in production
under development
concept phase con

The leading manufacturers of electronic components and peripherals have realized **significant cost savings** by specifying **LORIN AlumaPlusFine™.**

LORIN AlumaPlusFine™ out-performs painted or coated products – its **integrated colors won't flake or chip.** Enjoy new design freedom with **LORIN AlumaPlusFine™.**

Adherenc
to tighter toleranc
high-strength allo
selections, and
abrasion resistanc
make **LORIN**
AlumaPlusFine™
the material of
choice for audio,
video, and drive
components.

LORIN
INDUSTRIES

excellence in aluminum coil finishing

1960 S. Roberts, P. O. Box 766
Muskegon, MI 49443-0766
616 722 1631
fax 726 6186
800 678 1215

Call our EDS department for personalized service and a free specifier kit.

READER SERVICE 161

DEVELOPMENT TOOLS TARGET μCONTROLLERS

Archimedes IDE for Windows, an integrated software development environment, targets 8-, 16-, and 32-bit microcontrollers. The toolset integrates development tools for embedded systems under a Windows user interface for point and click control over all aspects of the software development cycle. It supports comprehensive debugging and error-handling options in real time or under simulation. Real-time debugging is supported by means of an emulator-based real-time debugger or in the absence of an emulator, with an embeddable ROM monitor utility. An integrated simulator enables C code execution and C source/assembly debugging before downloading code to the target system. List price, which starts at $1595, includes an editor, ANSI C compiler, intelligent linker/loader, C libraries, real-time debugger, simulator/debugger, and make utility. Hosts are PC, Vax, and Sun under Windows, OpenLook, and Motif. SVT

Archimedes Software, 2159 Union St., San Francisco, CA 94123; (415) 567-4010. **CIRCLE 822**

SOFTWARE ENSURES PCMCIA COMPATIBILITY

Installed on a hard disk, CardWare 2.0 ensures compatibility between any host device, such as a notebook or handheld computer, and more than 250 PCMCIA cards, including flash memory, fax/modem, rotating media, and LAN cards by what the company calls card information structure parsing. The software's "hot swapping" enables users to remove one PCMCIA software and replace it with another without reconfiguring or rebooting. A graphical user interface (GUI) keeps users informed of each step in the installation or removal process. Contact the company for pricing. SVT

Award Software International Inc., 777 East Middlefield Rd., Mountain View, CA 04043-4023; (415)968-4433;fax-0274. **CIRCLE 823**

SOFTWARE MODULE EASES ANALYSIS

S+DOX add-on software for MathSoft's S-Plus data analysis and programming environment supplies a customized set of graphics and analysis techniques that make it easier for technical professionals to use Design of Experiments (DOE) statistical methodology. It reduces complex experiments to smaller, more effective designs to save time and money. Also, S+DOX supplies powerful and easy-to-use graphical tools to analyze experimental results. S+DOX, which can be accessed through S-Plus for a complete environment, is $495 per copy for Windows; $795 for Unix platforms. SVT

MathSoft, 1700 Westlake Ave. N., Suite 500, Seattle, WA 98109-9891; (206)283-8802;fax-6310. **CIRCLE 824**

DESIGN IN
THE ULTIMATE
POWER SOURCE

When the world's foremost high-technology companies need to give their battery-powered products the longest life and greatest reliability, they turn to...
ULTRALIFE® lithium batteries.

- **9-volt** 10-year shelf life... Up to four times longer working life than alkaline.
- **3-volt** As compact as the 9-volt... same10-year shelf life... packs a capacity of 3600mAh.
- **ThinCell™** The most versatile battery system... as thin as 1/32 inch...standard and custom sizes for any application.

100% Mercury Free

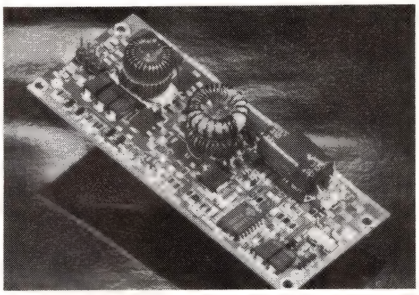
ULTRALIFE®
BATTERIES INC.

Find out how an Ultralife lithium battery will improve your product's performance.
Call (800) 332-5000 (315) 332-7100 Fax (315) 331-7800
Mail inquires to: PO Box 622, Newark, NY 14513 USA ©1994 Ultralife Batteries, Inc.

READER SERVICE 225

LOW-PROFILE CONVERTER POWERS DISKS, CD-ROMS

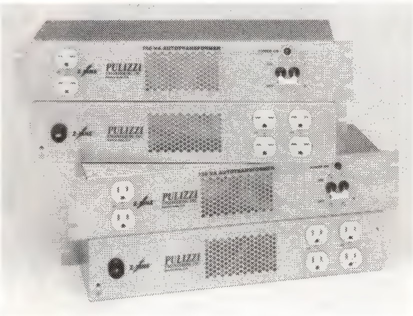
Converting inputs of 36 to 60 V dc to 5- and 12-V dc outputs, the model 10-0132-01 dual-output dc-dc converter powers large-capacity disk drives, CD-ROM drives, and other computer peripherals. The unit measures 4 by 1.7 by 0.8 in. and delivers 50 and 77 W peak output. Using thermal-clad board materials and surface-mount technology, the supply includes built-in heat sinking, remote on/off, and overvoltage and overcurrent protection. Call for pricing and delivery. DM



MicroENERGY Inc., 745 W. State Rd. 434, Longwood, FL 32750-4909; Gayle Bojerski, (407) 831-2000. **CIRCLE 825**

AUTO TRANSFORMERS RUN AT 750 VA MAXIMUM

A pair of automatic transformers steps voltages up or down according to application requirements. The systems are single-phase types that operate at a maximum of 750 VA. The model SDC 2102 reduces the operating voltage from an input of 200 to 250 V ac, single phase, to an output of 1200 to 125 V ac, single phase, at a maximum of 750 VA. The basic unit is designed for 19-in. rack mounting and is 3-1/2 in. high, 5 in. deep, and weighs 19 lbs. It has six NEMA 5-15R outlets. The model SUC 2103 increases operating voltage from an input of 100 to 125 V ac, single phase, to 200 to 250 V ac, single phase, also at a 750-VA maximum. List prices for the transformers are $475 for the step-down model and $515 for the step-up type. Call for delivery information. DM



Pulizzi Engineering Inc., 3260 S. Susan St., Santa Ana, CA 92704-6865; (714) 540-4229. **CIRCLE 826**

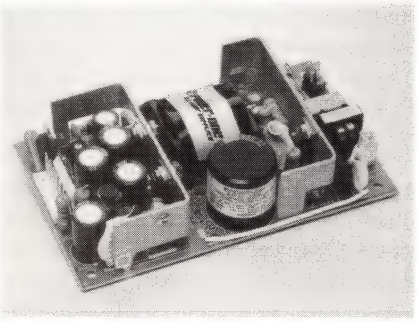
UNIVERSAL SWITCHERS SPAN GAMUT OF OUTPUTS

The Vulcan line of switching power supplies offers a wide range of inputs as well as a broad selection of voltage outputs from 3.3 to 24 V dc. The 20-W series is the first to be introduced in a family that's projected to include wall-mount versions for North America, Europe, and Great Britain, a universal-input desktop model, and open-frame and pc-board versions. Desktop models include single-, dual-, and triple-output versions in a 3.9-by-2.5-by-1.5-in. size. Pricing ranges from $25 to $29 in lots of 1000. Call for delivery information. DM

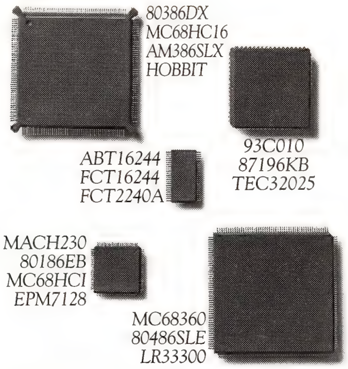
LZR Electronics Inc., 8051 Cessna Ave., Gaithersburg, MD 20879; (301) 921-4600. **CIRCLE 827**

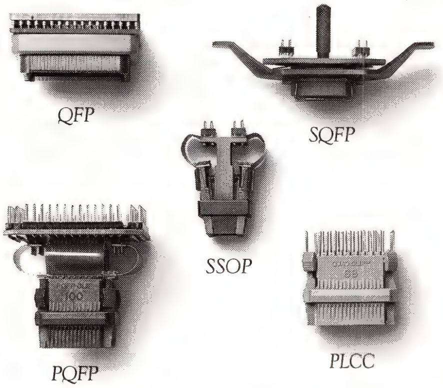
40-W POWER SUPPLY BOOSTS 5-V CURRENT

The MAP40-3500 is a 40-W power supply with more +5-V current than typical 40-W units: +5 V at 5 A, +12 V at 1 A, and –12 V at 0.5 A. The triple-output unit features automatic ac-input selection for worldwide operation over the input range of 90 to 264 V ac. On-board FCC and VDE filtering meets Class B conducted-emissions requirements, and the supply is recognized or certified to all major worldwide safety standards. Call for information on pricing and delivery. DM



Power-One Inc., 740 Calle Plano, Camarillo, CA 93012; (800) 678-9445. **CIRCLE 828**





FOR THOSE OF YOU WHO LIVE BY THE NUMBERS,

HERE'S THE EASIEST WAY TO CHECK EVERYTHING OUT.

THE WORLD'S LARGEST OFFERING OF TEST CLIPS.

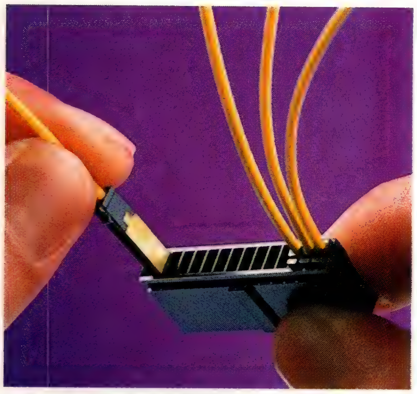
Today's boards contain chips that are too expensive to toss if they don't work. You could spend hours (or days) jury-rigging to access each lead because clock speeds and other functions make seeing everything essential.

Fortunately, Pomona offers a series of clips that allow you to test the newest chips on the market. And a FREE 1994 New Products Catalog makes finding the right test clip easy. Just look up the chip configuration or the device number, and you'll find the right Pomona test clip. You can also call direct for technical assistance at (909) 469-2912. Then call or visit your Pomona distributor for the clip you need. ITT Pomona Electronics, 1500 E. Ninth Street, Pomona, CA 91766-3835. (909) 469-2900. Fax (909) 629-3317.

ITT Pomona Electronics
AN ITT CANNON COMPANY

READER SERVICE 187

TYPICAL MERITEC CUSTOMER SOLUTIONS



READER SERVICE 106

Controlled Impedance Ground Plane Interconnects (GPI™) are Designed to Exceed 1 GHZ System Speeds

Meritec's new Ground Plane Interconnects are engineered to match critical application requirements for controlled impedance. A ground plane on the assemblies minimizes signal-to-signal crosstalk. The assemblies are designed for CMOS, ECL or GaAs logic and can handle system speeds exceeding 1 GHZ with 35 picosecond rise times. A spring latch connects the termination to the housing or to a carrier system to allow grouped interfacing with single, dual or triple row headers.

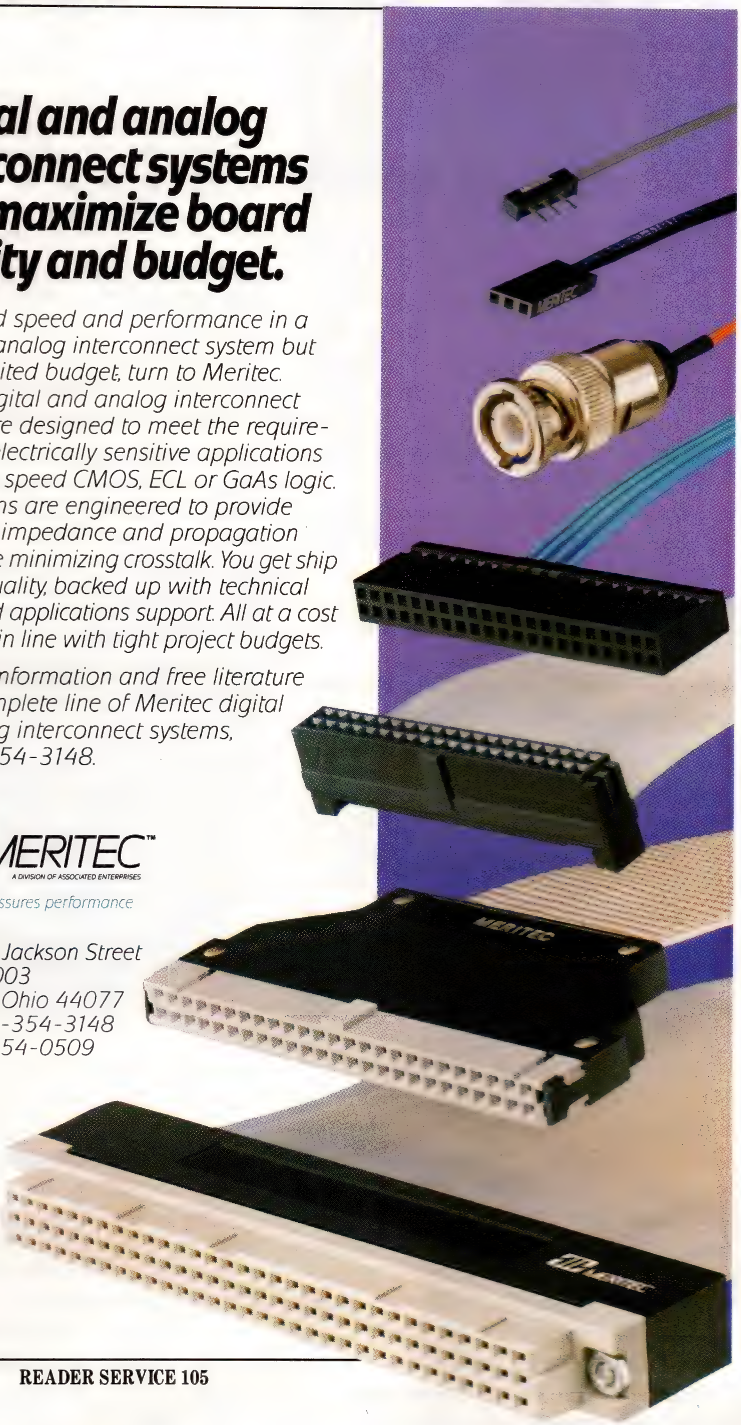
Digital and analog interconnect systems that maximize board density and budget.

If you need speed and performance in a digital or analog interconnect system but have a limited budget, turn to Meritec. Meritec digital and analog interconnect systems are designed to meet the requirements of electrically sensitive applications using high speed CMOS, ECL or GaAs logic. Our systems are engineered to provide controlled impedance and propagation delay while minimizing crosstalk. You get ship to stock quality, backed up with technical service and applications support. All at a cost that's well in line with tight project budgets.

For more information and free literature on the complete line of Meritec digital and analog interconnect systems, call 216-354-3148.

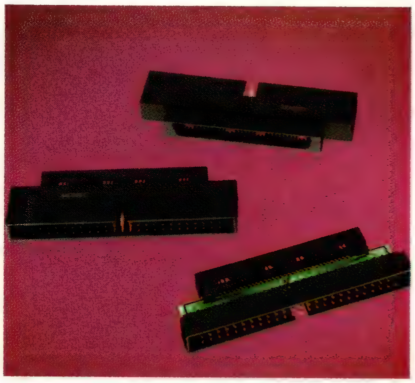
MERITEC™
A DIVISION OF ASSOCIATED ENTERPRISES
Where quality assures performance

1359 West Jackson Street
P.O. Box 8003
Painesville, Ohio 44077
Phone: 216-354-3148
FAX: 216-354-0509



READER SERVICE 105

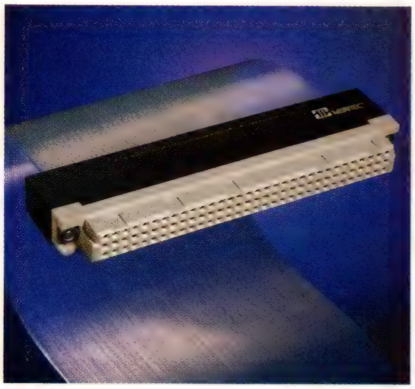
SCSI Interface Adapters



Meritec's SCSI Interface Adapters allow reliable interfacing of 8 bit-to-16 bit and 16 bit-to-8 bit devices. The adapters eliminate the need for multiple cable assembly configurations which would otherwise be needed to interface the devices. Short overall length between the mating faces allows dense packaging. The adapters are available in a variety of configurations, including 50-68 position female-to-female (for differential or single end mode systems), 50 position female-to-68 position male, 50 position male-to-68 position female and 50-68 position male-to-male. Customer-specific pinouts, filtering and terminations are available.

READER SERVICE 107

Multi Signal Interconnects for TTL Fast and Fast CMOS Logic



Meritec's controlled impedance Multi Signal Interconnects (MSI™) are designed for TTL fast and fast CMOS logic. Precision, high strength molded terminations provide high reliability in critical applications. Signals and grounds are all mass solder terminated. Grounds are bused to customer designated pins. The assemblies mate with standard .025" square or round pins on a .100" grid. Options include termination styles, daisy chain termination, EMI/RFI electrical shielding, center keys, pull tabs and many others.

READER SERVICE 108

FREE ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:

- Telecommunications
- Semiconductors
- Computers
- International Trade

☐ YES! Send me my FREE issue of *ELECTRONICS* and enter my 1-year subscription, 23 issues—for 10% off the regular subscription rate! If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates:
(U.S. funds drawn from a U.S. bank)

☐ U.S. ~~$98~~ $88
☐ Canada ~~$120~~ $108 (plus GST)
☐ Other Countries ~~$190~~ $171

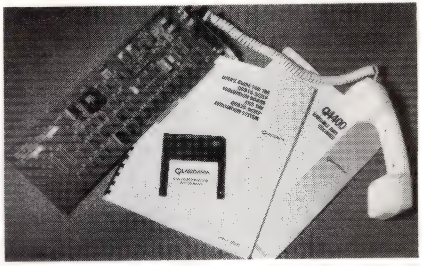
Please bill my credit card:
☐ Visa ☐ MasterCard
☐ AMX ☐ Discover

Card No. ____________________
Exp. Date ____________________
Signature ____________________
Date ____________________
Name ____________________
Title ____________________
Company ____________________
Mailing Address ____________________
____

Order by FAX: 216/696-6413
or call 216/696-7000, x 4137

EVAL BOARD EASES SPEECH COMPRESSION

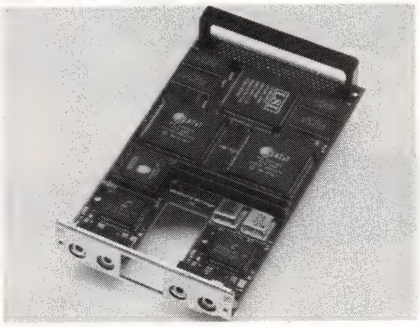
An easy-to-use plug-in evaluation board helps designers evaluate the Q4400 single-chip variable-rate vocoder. The Q0810 board offers a fully assembled and tested voice-coding circuit board and all the software that's needed to operate in record and playback modes. The Q4400 IC employs a proprietary algorithm that compresses digitized speech at bit rates ranging from 2 to 9.6 kbits/s. The board, which comes with a telephone handset, installs in any IBM-compatible PC. The Q0810 evaluation board sells for $1595 in small quantities. The Q4400 variable-rate vocoder costs $69 in lots of 1000. Both are available now. RN



Qualcomm Inc., 6455 Lusk Blvd., San Diego, CA 92121; (619) 587-1121. **CIRCLE 829**

SBUS MEZZANINE CARD HOLDS TWO DSPS

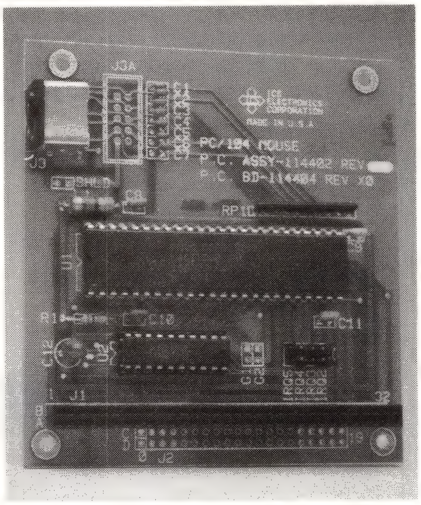
Available with either one or two processors, the SB32C is an SBus-based board that's built with the AT&T DSP32C floating-point digital-signal processor. The single-processor model (SB32C1) features a peak performance of 25 MFLOPS and supplies one stereo codec and 512 kbytes of private SRAM. The dual-processor board (SB32C2) pushes out 50 MFLOPS and holds 1 Mbytes of zero wait-state SRAM (512 kbytes per DSP), and four CD-quality audio I/O channels. The 32-bit SBus interface supports master and slave transfer modes and can sustain DMA transfers to and from the DSP's memory at of 3.5 Mbytes/s. There's also a separate 80-pin connector that enables mezzanine cards to access the boards' DSP serial ports, interrupt lines, codec control lines, and DSP memory space. Development support includes an AT&T compiler, a DSP32C assembler, driver for the Solaris and SunOS operating systems, and a Unix library of C-callable functions for host-to-DSP communications. The SB32C1 costs $1500, while the SB32C sells for $2500. RN



Communication, Automation and Control Inc., 1642 Union Blvd., Suite 200 Allentown, PA 18103; (800) 367-6735 or ((610) 776-6669. **CIRCLE 830**

CONNECT MOUSE TO EMBEDDED COMPUTER

Fitting the PC/104 form factor, the PC/104 Mouse module features a Logitech three-button mouse and driver. It permits the addition of a mouse to any embedded computer without giving up a serial port or creating interrupt-request (IRQ) conflicts. The module is similar to a bus-mouse card, yet it fits the 3.55- by 3.77-in. form factor. On-board jumpers allow for the selection of IRQ levels two through five. Mouse connection is made through a 9-pin mini-DIN connector. A 9-pin header is also supplied on the board, so the mini-DIN can be located in a different position. With a mouse and the driver, the PC/104 Mouse sells for $150. RN



ICS Electronics Inc., 473 Los Coches St., Milpitas, CA 95035; (408) 263-5500. **CIRCLE 831**

You Need Tree City USA

City trees add the soft touch of nature to our busy lives. They cool our cities, fight pollution, conserve energy, give wildlife a home, and make our neighborhoods more liveable.

The trees on city property, along streets and in parks, are an essential part of the urban forest. To keep these trees healthy and abundant, your town needs an organized program for their care…an annual action plan to plant and prune the city's trees, and to maintain their health.

You can make a difference — by planting and caring for trees in your yard and in your neighborhood, and by encouraging your city government's community forestry program.

Support Tree City USA where you live. For your free booklet, write: Tree City USA, The National Arbor Day Foundation, Nebraska City, NE 68410.

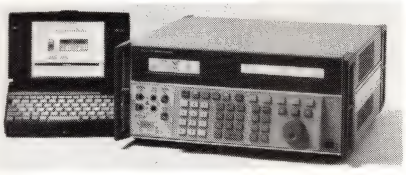
The National Arbor Day Foundation

LOW-COST DATA BOARD HAS 16 INPUT CHANNELS

The PCI-20428W is a full-featured data-acquisition board aimed at OEMs and cost-sensitive applications. The board features 16 analog input channels (12 bits at 100 kHz), two analog output channels (100 kHz), eight digital inputs, eight digital outputs, one counter/timer, concurrent analog input and output DMA capability, a rate generator, and software drivers. Two versions are available. One has programmable gains of 1, 10, and 100. The other has programmable gains of 1, 2, 4, and 8. Included are C libraries for DOS and Windows DLL support. The libraries are compatible with the company's Master Link software libraries, which are available separately. The PCI-20428W costs $395 and is available immediately. JN

Intelligent Instrumentation, 6550 S. Bay Colony Dr., MS130, Tucson, AZ 85706; (800) 685-9911 or (602) 573-0887. **CIRCLE 832**

UNIT CALIBRATES MANY TYPES OF PRODUCTS



The 5500A Multi-Product Calibrator lets users calibrate a wide range of dc-to-low-frequency instruments. Capabilities include digital and analog multimeters and oscilloscopes to 200 MHz, thermocouple and RTD thermometers, power meters, power harmonics analyzers, process calibrators, chart recorders, data loggers, panel meters, and current clamps. Optional Windows-based software automates calibration procedures and documentation. The 5500A sells for $9995. The oscilloscope option (5500A-SC) is $6500, and the 5500/CAL software is $2500. JN

Fluke Corp., P. O. Box 9090, Everett, WA 98206-9090; (800) 443-5853 or (206) 356-5500. **CIRCLE 833**

PROGRAMMER HANDLES WIDE ARRAY OF PARTS

As a standalone programmer for embedded microcontrollers, semiconductor memory, and programmable logic devices, the Model 2000 uses reprogrammable gate arrays to handle a wide range of pinouts and package types. The unit efficiently writes data from any RAM address to as many as 16 sockets in parallel, but reads and verifies them individually. Eight, 16-, or 32-bit wide devices can be programmed in block, interlace, block/interlace, or gang operation. Free lifetime device updates are available from the company's 24-hour online bulletin-board system. Users can transfer the updates to the Model 2000 through its 3.5-in. disk drive. The Model 2000 standalone device programmer costs $1995. Socket modules start at $995. Delivery is in one to two weeks. JN

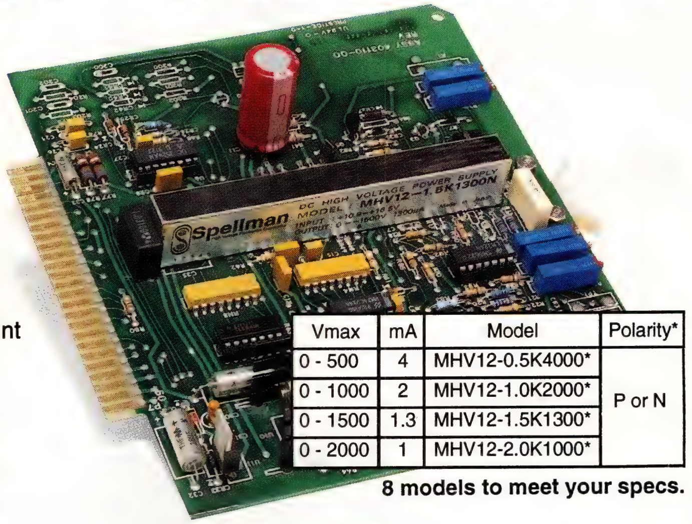
Bytek Corp., 543 N.W. 77th St., Boca Raton, FL 33487; (407) 994-3520 or (800) 523-1565. **CIRCLE 834**

2W at 2kV on 2in^2!

These unique, well-regulated 2kV power supplies will drive your photomultiplier tubes, solid state detectors, flow sensors and spectral lamps -- in a mere "toe print" on your PC board.

Reduce your power supply space requirement by 80% and increase PC board packaging density significantly with Spellman's integrated surface-mount MHV series.

Regulation is 0.03%. All modules are vibration and shock resistant. They are EMI/RFI shielded with Spellman's unique, sealed-metal case construction. Order MHV now for your current design projects. It will change the way you think about power supplies.



Vmax	mA	Model	Polarity*
0 - 500	4	MHV12-0.5K4000*	P or N
0 - 1000	2	MHV12-1.0K2000*	
0 - 1500	1.3	MHV12-1.5K1300*	
0 - 2000	1	MHV12-2.0K1000*	

8 models to meet your specs.

Only $250 each.
Shipped from stock.
To order call:
(516) 349-8686 FAX (516) 349-8699

Spellman

Spellman High Voltage Electronics Corp.
7 Fairchild Avenue, Plainview, NY 11803

READER SERVICE 230

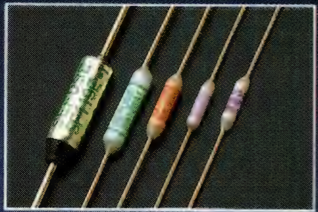
The world's smallest thermal cutoff

SM/G-Series provides fast response in tight spots.

Safety concerns don't go away just because products shrink in size. In fact, the need to protect costly circuits against abnormal heat has become even more critical in today's high-density, miniaturized products. That's why NEC has developed a new series of thermal cutoff devices engineered for space-sensitive applications. Our SEFUSE™SM/G devices are only 5mm long and 1.6mm in diameter. Half the size of previous cutoffs, they're twice as fast in responding to emergencies.

NEC is a leading supplier of thermal cutoffs for both small- and large-current applications. The devices in our SEFUSE SM-Series handle rated currents of 0.5A, 1A and 2A with a thermal pellet made of a fusible alloy and sealed in a ceramic case. The devices in our SF/E-Series handle a rated current of 10A with an organic thermo-sensitive pellet sealed in a metal case.

SEFUSE devices are mass-produced at NEC's highly automated facilities. They conform to all the world's major safety standards, including UL, CSA, VDE, BEAB and MITI (Japan). And they'll help you conform to the industry-wide trend toward greater safety.



If you agree that no product is too big or too small for an extra margin of security, find out about our SEFUSE cutoff devices today.

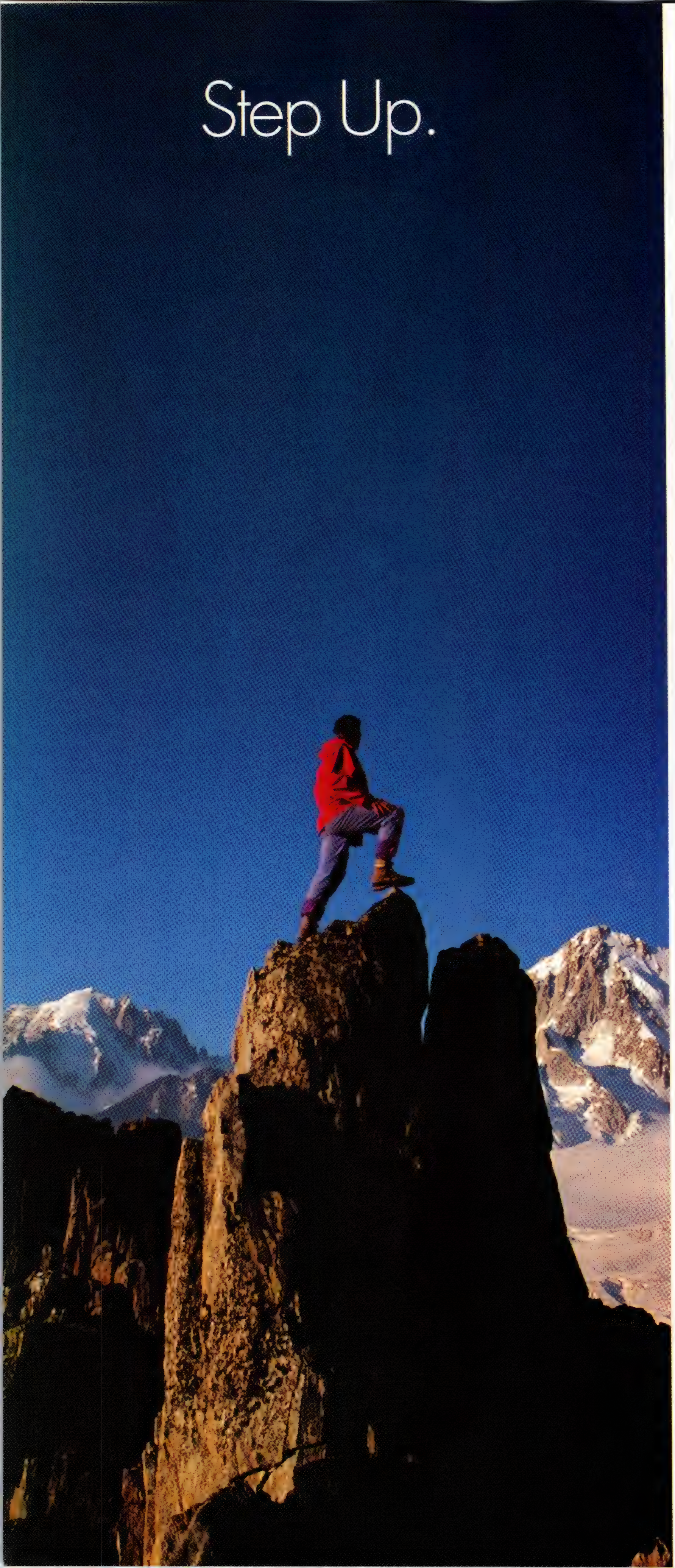
Series	Rated Operating Temperature	Rated Current (AC)
SF/E	73°C – 240°C	10A
SM/A	70°C – 187°C	2A
SM/B	100°C – 150°C	1A
SM/G	100°C – 150°C	0.5A
SM/GP	100°C – 150°C	0.5A

Rated Voltage: 250V (AC)

The right components to build your reputation.

For fast answers, call us at:
USA Tel:1-800-366-9782. Fax:1-800-729-9288. **Hong Kong** Tel:886-9318. Fax:886-9022. **Taiwan** Tel:02-719-2377. Fax:02-719-5951.
Singapore Tel:253-8311. Fax:250-3583. **Australia** Tel:03-8878012. Fax:03-8878014. **Japan** Tel:03-3798-6148. Fax:03-3798-6149.

NEC



To Peak HDL Performance.

When you just want to get to synthesis, do hard-to-use VHDL methodologies put you between a rock and a hard place? Then rise above them. Step up to Visual HDL™ and Xpert HDL,™ two high-powered, high-level productivity solutions from Summit Design.

From the moment you start up, Xpert HDL helps you and your design team perform at your peak. Easy to learn, easy to use, it's an object-oriented VHDL capture environment packed with features that speed every step of the way. Syntax-aware editing for higher accuracy. With VHDL code management for greater control. And synthesis-style checking for early error detection.

Visual HDL boosts your productivity to even greater heights. The only HDL solution that freely integrates VHDL with four graphical languages, it lets you express your design in the medium of your choice, debug at the highest levels, and produce synthesis-ready VHDL.

So, set your sights on new productivity and design quality heights. Give us a call at 1-800-700-5977. Let us tell you more about Xpert HDL, Visual HDL, and how they'll help you reach the top of your top-down design.

SUMMIT

Summit Design, Inc

Raising Design Productivity to New Height

9305 S.W. Gemini Drive, Beaverton, OR 97005-7158
Summit Design and Summit Logo are trademarks of Summit Design, Inc.

CIRCLE 262

VOLTAGE-FEEDBACK IC OP AMPS HANDLE SIGNALS TO OVER 220 MHZ

A pair of voltage-feedback IC op amps from Analog Devices, the AD9631/AD9632 offer the previously unavailable combination of spurious-free dynamic range, small- and large-signal bandwidth, and slew rate. The large-signal bandwidth of earlier wide-band voltage-feedback op amps did not track the devices small-signal bandwidth. The two ICs, which result from the company's bonded-wafer complementary bipolar process (XFCB), are designed for stable closed-loop gains of one and two respectively. At a gain of 1, while driving 100 Ω and running off ±5 V, the AD9631 provides a minimum small-signal (400 mV p-p) and minimum large-signal (4 V p-p) 3-dB bandwidths of 220 MHz and 150 MHz, respectively. Under similar conditions, but at a closed-loop gain of 2, its sibling provides minimum large and small-signal 3-dB bandwidths of 180 MHz and 155 MHz, respectively.

Typical bandwidth for 0.1-dB gain flatness, while driving 100 Ω with 300 mV, runs 130 MHz. Minimum slew rate of the 9631 runs 1000 V/µs; of the 9632, 1200 V/τs. Their output typically settles to 0.1% and 0.01% for a 2-V step in 11 ns and 16 ns, respectively. Aimed at handling precision video signals, the op amps provide a maximum differential gain and phase error of 0.06% and 0.04° at 3.58 MHz, while driving 150 Ω. Typical phase non-linearity from dc to 100 MHz runs 1.1°. Maximum second harmonic distortion for a 2-V p-p signal at 20 MHz runs –57 dB for the AD9631; –47 dB for the AD9632. Under similar conditions, maximum third harmonic distortion run –69 dB and –67 dB, respectively.

While designed for wide-band ac applications, the ICs' minimum/maximum dc specifications (measured at a closed-loop gain of 50) are typical of wide-band op amps designed for low-gain operation. Open loop gain is 46 dB, offset voltage is ±10 mV for the 9631, half that for the 9632. Offset drift is typically ±10 µV/°C. Maximum bias current runs 7 µA and maximum common mode rejection ratio is 70 dB. The op amps can run from split ±3- to ±6-V rails with a maximum quiescent current of 21 mA. They operate over the extended industrial temperature range and come in 8-pin DIPs and SOICs. Military temperature versions come in Cerdip packages. In lots of 1000, they start at $4.12 each.

Analog Devices Inc., *181 Ballardvale St., Wilmington, MA 01887; (617) 937-1428.* **CIRCLE 835**

■ *FRANK GOODENOUGH*

README.TXT!
(Engineers Only)

Now you can **design** new products and **bring them to market** with **dazzling speed** through design, prototyping and hassle-free production. Your manufacturing and marketing associates will love you — making **concurrent engineering** a dream come true!

Just Talk to Lumex...

Harnessing photons in visible and near-infrared wavelengths is ***our only specialty***. Use our pre-harnessed photons on PC board and panel indicators, illuminators, coupled with sensors and as surge protectors. They are available as LED lamps, LED displays, gas plasma tubes and filament lamps. And they come in packages designed and built JUST FOR YOU — ***with no or very small up-front tooling costs*** — and with dazzling turn-around times!

FAX Your Requirements To 1-800-944-2790
Attention: Chief Sales Engineer

LUMEX
OPTO/COMPONENTS, INC.

292 E. Hellen Road
Palatine, IL 60067
Tel: 1-708/359-2790
FAX: 1-800/944-2790

Get Your Design *LUMEXized!*

READER SERVICE 102

13-BIT DACs ON ONE CHIP GUARANTEE MONOTONICITY

Designed for applications ranging from ATE to an eclectic variety of instrumentation systems, the MAX547 squeezes a total of eight, 13-bit voltage-output d-a converters into 44-pin flatpacks and PLCCs. It easily replaces the combination of eight, 12-bit, current-output d-a converters and eight precision op amps while delivering twice the resolution.

All of the DACs guarantee monotonic operation over their operating temperature range (differential nonlinearity runs a maximum of ±1 LSB). Versions screened for military, extended industrial, and commercial temperatures are available. Integral nonlinearity (relative accuracy) typically runs better than ±0.5 LSB. Operating from split ±5-V supply rails, DAC outputs can be configured to provide unipolar or bipolar output swings of ±4.2 V across 10 kΩ and 50 pF while slewing at 3 V/µs. The chip's high-speed, double-buffered parallel-logic port, and its 5-µs settling time allow for fast updating. The output of all eight DACs are reset to zero at power up. In quantities of 1000 units, pricing starts at $29.60 each.

Maxim Integrated Products, *120 San Gabriel Dr., Sunnyvale, CA 94086; (800) 722-7600, ext. 6326.* **CIRCLE 836**

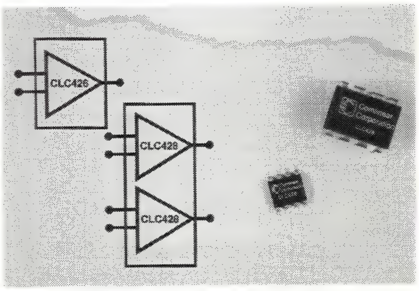
■ *FRANK GOODENOUGH*

130-MHz OP AMPS OFFER 1.6-nV/√Hz NOISE

A pair of wide-band (130-MHz), low-noise IC op amps, the CLC426 and CLC428, are challenging the current-feedback op amps' domain. The single CLC426 is stable down to noise gains of 2 (closed-loop gains of +2 or –1), while both op amps in the dual CLC428 are stable to noise gains of 1 (closed-loop gain of +1). However, most specifications (all typical) are provided at closed loop gains of +2, while driving 50 Ω (feedback and load resistors equal 100 Ω).

Although stable at low gains, the devices' low-noise and low-offset voltage lend them to high-gain applications, albeit dc open-loop gain typically runs only 60 dB. Both devices can operate from single or split supplies.

Under the conditions listed, small-signal (500-mV p-p) – 3-dB bandwidth of the CLC426 runs 130 MHz, while large-signal (5-V p-p) bandwidth runs 50 MHz. Input voltage and current noise from 1 MHz to 100 MHz runs 1.6 nV/√HZ, and 2 pA/√HZ, respectively, while offset voltage runs less than ±1 mV and offset drift less than ±3 µV/°C. Settling time for a 2-V step to 0.05% runs 16 ns, and it slews at 500 V/µs.



Second and third harmonic distortion for a 1-V p-p signal at 10 MHz runs –62 and –68 dB, respectively. The op amp features an external supply current adjustment, permitting designers to optimize power, bandwidth, noise, and distortion for each application. It draws 11 mA from the split ±5-V rails. In quantities of 1000, it goes for $3.95 each.

The dual CLC428 provides small- and large-signal – 3-dB bandwidths of 80 and 40 MHz, respectively, however settling time, slew rate, noise, distortion, and most other specifications are similar to that of its sibling. In quantities of 1000, it goes for $5.49 each.

Comlinear Corp., *4800 Wheaton Dr., Fort Collins, CO 80525-9483; (303) 226-0500* **CIRCLE 837**

■ *FRANK GOODENOUGH*

FREE ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensable source for industry news, trends and analysis in key markets:

- Telecommunications
- Semiconductors
- Computers
- International Trade

☐ **YES! Send me my FREE issue of *ELECTRONICS* and enter my 1-year subscription, 23 issues—for 10% off the regular subscription rate! If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.**

One year subscription rates:
(U.S. funds drawn from a U.S. bank)
☐ U.S. ~~$98~~ $88
☐ Canada ~~$120~~ $108 (plus GST)
☐ Other Countries ~~$190~~ $171

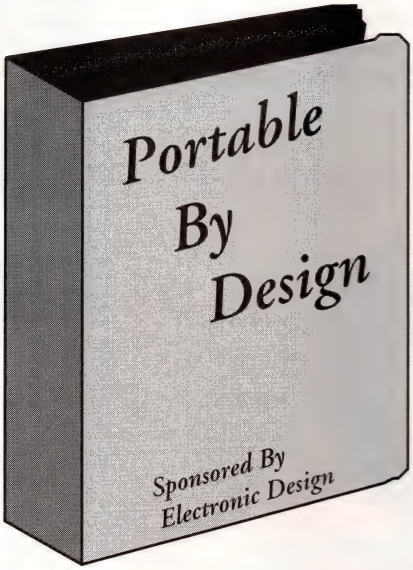
Please bill my credit card:
☐ Visa ☐ MasterCard
☐ AMX ☐ Discover

Card No. ____________
Exp. Date ____________
Signature ____________
Date ____________
Name ____________
Title ____________
Company ____________
Mailing Address ____________

Order by FAX: 216/696-6413
or call 216/696-7000, x 4137

Proceedings of Portable By Design

Sponsored By Electronic Design Magazine



Price $150.00 per copy (add $12.00 shipping & handling per copy)

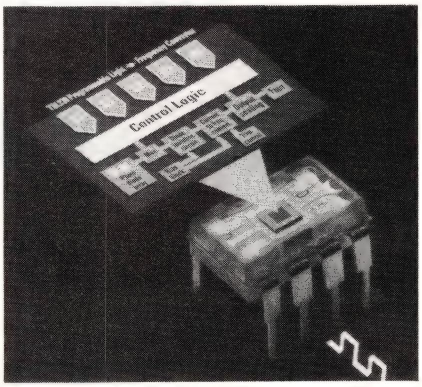
A conference for OEM Designers of portable, nomadic, mobile, transportable and hand-held products. The product areas covered in these proceedings include almost 800 pages of information on:

* Power Circuits
* Connectivity
* Input Devices
* Managing Mechanical/Electrical Design Teams
* Expandability/Configurability
* Engineering The Whole System
* High End Microprocessors
* Low-Power Microncontrollers
* Power Management
* Application Development & Operating Systems
* Batteries
* Displays

For additional or ordering information, please call (201) 393-6075

TINY 8-PIN SMALL-OUTLINE IC SENSOR ARRAY CONVERTS LIGHT TO FREQUENCY

Aimed at applications ranging from environmental-pollution monitoring systems to color sensing and controlling photographic exposures, the TSL230 from Texas Instruments is the industry's first integrated light-to-frequency sensor. Count its output pulse train, and the system has converted light intensity to a digital word.



When monitoring pollution, precise, cost-effective, light-intensity analysis can measure fluid opacity, control chemical processes, and detect ultraviolet light.

Needing just 5 mW of power from a 3-V rail, the integrated circuit combines the work of a photodiode, a low-bias-current op amp, and a voltage-to-frequency converter. Its sensitivity is pin programmable using an electronic aperture technique to one of three settings—1x, 10x, or 100x. Consequently, it provides systems built with the TSL230 a dynamic range of 160 dB.

The IC's serial output can go directly to a microcontroller, a digital-signal processor, or digital logic for processing, depending upon the speed, accuracy, and cost requirements of the application.

In most applications, the TSL230 SOIC sensor array and a small microcontroller will replace high-resolution analog-to-digital converters, while at the same time actually raising the dynamic range and reducing cost.

The chips user-programmable output scaling allows the output frequency range to be optimized for various microcontroller speeds and measurement techniques.

The TSL230 comes in a clear plastic, 8-pin dual in-line package. In quantities of 1000 units, they cost $2.76 each.

Texas Instruments, Box 172228, Denver, CO 80217; (800) 477-8924, ext. 4500. **CIRCLE 838**

■ *FRANK GOODENOUGH*

Do CAD-vendors listen to designers?

Now a unique offer
to 'accelerate the write-off' of your old CAD-System

Instead you get a top model from Ultimate Technology, the reliable European Supplier that does listen to their users (regular surveys and User Group meetings available to all users). ULTIboard became famous for its guaranteed Design Integrity: thanks Real Time Checks mistakes are prevented! The project duration will be substantially shortened compared to less intelligent systems which find mistakes during post process checks.

SPECIAL OFFER

*No matter what brand, does not apply to demo sysytems. Althought not designed for Challenger users, this unique offer is also available to them!

If you order the ULTIboard Advanced Designer System before September 30, 1994, mentioning your current CAD System & Version number*, you pay only US$ 1.785 instead of US$ 2.975 (excl. S&H/taxes) for this top of the line 32-bit 2.800 pin design capacity Schematic and PCB Design System, including the advanced Ripup & Retry Autorouter ULTIroute GXR!

IN TEST ELRAD

For Designers ULTiBOARD by Designers

More than 10.000 users

With ULTIboard there are no surprises thanks to the Full Feature Evaluation System (200 pin design capacity, includes full color intro- and tutorial manuals) available for only US$ 40 (excludes S&H).

Also available is a full function Evaluation System (as described above, with a 200 pin design capacity and including Introduction and Tutorial manuals) for only US$ 40 excl S&H/Tax).

ULTIMATE TECHNOLOGY Corporate Headquarters: Energiestraat 36, 1411 AT Naarden the Netherlands, tel. (+31) 2159 - 44444, fax 43345 Intern. Reply number 464, NL 1400 WC Naarden (no postage required)

USA & CANADA	C.C.D.	tel.: 1-800-2676631	fax: 519-6512259	PORTUGAL	Ferreira & Bento	tel.: 01-3152763	fax: 522643
GR. BRITAIN	ULTIMATE	tel.: 0734-812030	fax: 815323	GREECE	Micronics	tel.: 01-9914786	fax: 9951814
GERMANY	Taube Electronic	tel.: 030-6914646	fax: 6942338	TURKEY	Eptam	tel.: 216-4114412	fax: 4114413
	Infocomp GmbH	tel.: 09721-18474	fax: 185588	DENMARK	DeSeCAM	tel.: 048-241204	fax: 241204
	PDE CAD Systeme	tel.: 08024-91226	fax: 91236	NORWAY	Teleinstrument	tel.: 66-901190	fax: 901212
	Kmega GmbH	tel.: 07721-91880	fax: 28561	SWEDEN	Terco	tel.: 08-7405500	fax: 7404201
BELGIUM	ULTIMATE	tel.: 015-401895	fax: 401897	ICELAND	DNG Electronics	tel.: 96-11122	fax: 11125
	Fellin CAO-DAO	tel.: 087-882755	fax: 890072	SLOVENIA	Safe International	tel.: 061-1591568	fax: 1591568
	PCB Design Serv.	tel.: 051-316585	fax: 314632	JAPAN	KK Rocky	tel.: 03-32284511	fax: 33881391
	Minelec	tel.: 02-4603175	fax: 4610024	TAIWAN/CHINA	Leesel International	tel.: 02-7059063	fax: 7032010
	C. Electr. Liegeois	tel.: 041-234541	fax: 237413	KOREA	KKIC	tel.: 02-5653090	fax: 5640975
NETHERLANDS	ULTIMATE	tel.: 02159-44444	fax: 43345	SINGAPORE	SamCom Electronics	tel.: 7841100	fax: 7841227
FRANCE	Partner	tel.: 086-335032	fax: 335017	AUSTRALIA	Jet-Power Pty. Ltd.	tel.: 03-8080745	fax: 8083513
	Setia	tel.: 067-521202	fax: 045611	NEW ZEALAND	RA Bell Instruments	tel.: 04-4764516	fax: 4767676
ITALY	Kevin	tel.: 02-48706300	fax: 48706500	ARGENTINA	Varimak	tel.: 01-7931617	fax: 7931336

DISTRIBUTOR INQUIRIES WELCOME at our Corporate Headquarters.

Technical support from multinational Company established in 1973. Local duties (non EC) and/or sales tax may apply.
ULTIboard, ULTIcap and ULTImate are (registered) trademarks of ULTimate Technology BV/Ltd/GmbH/Corp. All trademarks are of their respective companies.

READER SERVICE 142

WORLD CUP

PERFORMANCE WORLDWIDE

Certified according to DIN ISO 9001

8 Pin Straight Backplane Module
ngled
er Card
6 Pin Straight Backplane Module With Red Protection Cap
le Assembly
HARTING

Here's how HARTING'S new modular 50Ω micro-coaxial contact, designed for high speed data transfer rates, answers the needs of permanently increasing density and transfer rates of electronic components in telecommunications and computer equipment.

- **Provides More Space Efficiency** - 2, 4 or 6 contacts in just 25 mm of board edge. High density allows up to 60 coax - connections on a double eurocard.
- **High Frequency Capability** - allows transmission of signals up to 2.5 GHz. 50Ω controlled impedance. VSWR 1.25:1 (at 50Ω, up to 2 GHz). Insertion loss 0.25 dB.
- **Easy Handling** - Approved technology, solderless, press-in terminations. Mating force per contact ≤ 5N
- **Cost Efficiency** - Modular tool system with quickly exchangeable tools and inserts for all types of applications. Protection caps give protection during transport and allow assembly with flat rock tooling.
- **Application Flexibility** - Compatible with 19″ rack equipment practice and IEC/IEEE Metric equipment practice.

PCB termination on both daughterboard to backplane connection permits bringing signals directly into the backplane without a cable transition. Add the high quality (ISO 9001CERTIFIED) and dependable performance and service HARTING is known for worldwide and you have a WIN-WIN opportunity. Call, FAX or write:

Complete information and expert application assistance available

vailable from
APSTONE
nd other
uthorized
ARTING
istributors

See us at Wescon Booth #1381, 1383, 1385

Connectors from HARTING – the quality connection

HARTING ELEKTRONIK, INC. 2155 Stonington Ave., Suite 212
P.O. Box 95710, Hoffman Estates, Illinois 60195
Phone: 708/519-7700 • Fax: 708/519-9771

HARTING

READER SERVICE 148

FREE ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensable source for industry news, trends and analysis in key markets:

- Telecommunications
- Semiconductors
- Computers
- International Trade

☐ YES! Send me my FREE issue of *ELECTRONICS* and enter my 1-year subscription, 23 issues—for 10% off the regular subscription rate! If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates:
(U.S. funds drawn from a U.S. bank)
☐ U.S. ~~$98~~ $88
☐ Canada ~~$120~~ $108 (plus GST)
☐ Other Countries ~~$190~~ $171

Please bill my credit card:
☐ Visa ☐ MasterCard
☐ AMX ☐ Discover

Card No. ____________________

Exp. Date ____________________

Signature ____________________

Date ____________________

Name ____________________

Title ____________________

Company ____________________

Mailing Address ____________________

____

Order by FAX: 216/696-6413
or call 216/696-7000, x 4137

3.5-IN. DISK DRIVES SUIT SERVER APPS

Designed for desktop PCs, workstations, servers, and RAID subsystems, the 3.5-in. Filepro Performance series of hard-disk drives offer capacities of 2- and 4-Gbytes. The 8.5- to 9.5-ms access time and low latency comes from the 5400- or 7200-rpm rotational speed. Available interfaces include 50-pin fast SCSI 2, 68-pin D-type fast and wide SCSI 2, and 80-pin Single-Connector Attachment (SCA) fast and wide SCSI 2. The 2105 is a five-platter drive that spins at 5400 rpm. It offers a head-to-media transfer rate of 73.1 Mbits/s and a 2-Gbyte capacity and sells for $1095. The 2-Gbyte 2107 spins at 7200 rpm, improving the transfer rate to 87.4 Mbits/s. It costs $1195. The $1895 4207 uses ten platters to store 4 Gbytes. It also spins at 7200 rpm. Each has a minimum cache buffer of 512 kbytes. The MTBF is rated at one million hours. In addition, the drives consume just 5.9 to 12.7 W in idle mode, making them suitable for applications where low heat output is needed to maintain data integrity. RN

Conner Peripherals Inc., 3081 Zanker Rd., San Jose, CA 95134; (408) 456-4500. **CIRCLE 839**

NOTEBOOKS OFFER MULTIMEDIA FUNCTIONS

Two new members have joined the TravelMate 4000M series of high-performance multimedia notebook computers. The 4000M/50 Dual-Scan Color and Active-Matrix Color feature a 50-MHz SL-enhanced 486SX2 microprocessor, a Type III PCMCIA card slot, an integrated pointing device, and built-in multimedia capabilities. The notebooks are compatible with a CD-ROM docking station. The multimedia functionality comes from the ability to handle Indeo video technology and integrated 16-bit audio. The standard 4 Mbytes of 60-ns DRAM is expandable to 20 Mbytes. There's also 1 Mbyte of video memory. The units weigh under 5 lbs., including the NiMH battery. Prices for the 4000M/50 systems start at about $3000. RN

Texas Instruments Inc., P.O. Box 6102, MS 3242, Temple, TX 76503; (800) TI-TEXAS. **CIRCLE 840**

SPARCSTATION SYSTEMS OFFER UPGRADE PATH

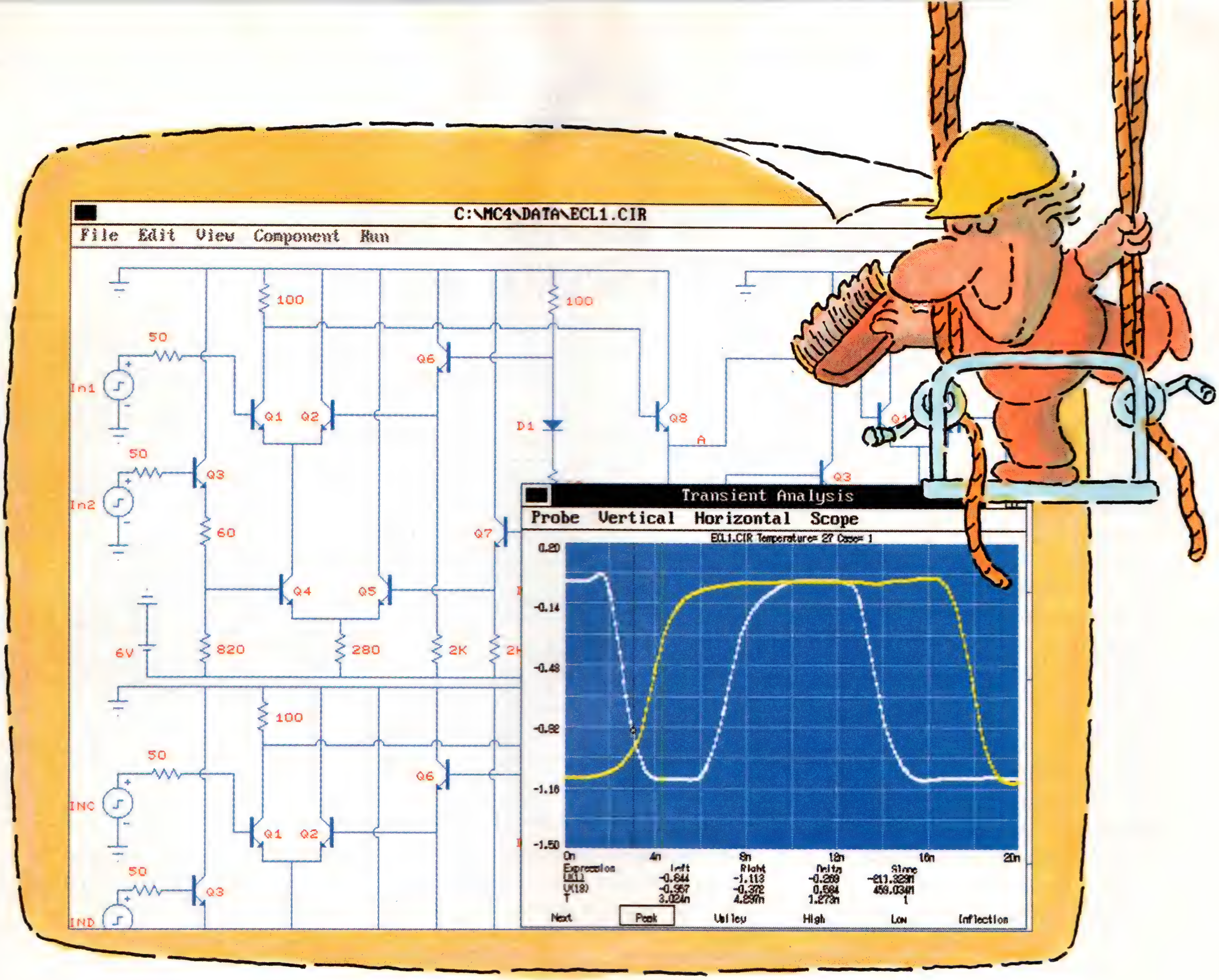
Two SparcStation 5-compatible workstations are built with microSparc II processors and offer an upgrade path to the SparcStation 20 level. The SWS5 series is suited for CPU-intensive applications, such as graphics and CAD. The SWS5/85 comes with an 85-MHz processor and a 24-kbyte cache to supply 64 SPECint92 and 55 SPECfp92. The SWS5/100 is designed with a 100-MHz microprocessor to perform 70 SPECint92 and 61 SPECfp92. It also offers a 24-kbyte cache. Both systems have three SBus expansion slots, a 64-bit AFX graphics bus, and room for up to 256 Mbytes of RAM. Standard interfaces include one parallel and two serial ports, a fast SCSI-2 interface, a 16-bit audio connector, and a 10-BaseT twisted pair capability. Prices start at $3495. RN

Integrix Inc., 1200 Lawrence Dr., Suite 150, Newbury Park, CA 91320; (800) 300-8288 or (805) 375-1055. **CIRCLE 841**

FLASH CARDS PERMIT XIP

A series of flash-memory cards, ranging 2 to 10 Mbytes in capacity, offer an execute in place (XIP) capability. Using XIP, an application program stored in the card is executed directly from the card without having to be loaded into RAM. This approach produces a smaller and faster system with a longer battery life. The cards permit designers to build systems with less RAM, thus reducing costs. The cards could even serve to eliminate hard-disk drives from portable systems. They conform to the PCMCIA 2.0 specification and fit the Type I form factor. Four capacities are available—2, 4, 8, and 10 Mbytes. Memory can be organized in either a byte- or word-wide format. Access times are 250 ns, maximum. System performance can be further improved by combining the cards with flash file system designed for blocked media. Prices for the cards start at $230 in quantities of 500. RN

Hitachi America Ltd., Semiconductor and IC Div., 2000 Sierra Point Pkwy., MS-080, Brisbane, CA 94005; (800) 285-1601, ext. 16. **CIRCLE 842**



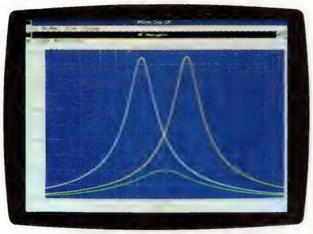
Expression	Left	Right	Delta	Slope
V(1)	-0.844	-1.113	-0.269	-211.329M
V(18)	-0.957	-0.372	0.584	459.034M
T	3.024n	4.297n	1.273n	1

INTRODUCING MICRO-CAP IV.™ MORE SPICE. MORE SPEED. MORE CIRCUIT.

PC-based circuit analysis just became faster. More powerful. And a lot easier. Because MICRO-CAP IV is here. And it continues a 12-year tradition of setting CAE price/performance standards.

Put our 386/486 MICRO-CAP IV to work, and you'll quickly streamline circuit creation, simulation and edit-simulate cycles — on circuits as large as 10,000 nodes. In fact, even our 286 version delivers a quantum leap upward in speed. Because, for one thing, MICRO-CAP IV ends SPICE-file-related slowdowns; it reads, writes and analyzes SPICE text files and MC4 schematic files. It also features fully integrated schematic and text editors. Plus an interactive graphical interface — windows, pull-down menus, mouse support, on-line HELP and documentation — that boosts speed even higher.

Now sample MICRO-CAP IV power. It comes, for example, from SPICE 2G.6 models plus extensions. Comprehensive analog behavioral modeling capabilities. A massive model library. Instant feedback plotting from real-time waveform displays. Direct schematic waveform probing. Support for both Super and Extended VGA.


AC Analysis

And the best is still less. At $2495, MICRO-CAP outperforms comparable PC-based analog simulators — even those $5000+ packages — with power to spare. Further, it's available for Macintosh as well as for IBM PCs. Write or call for a brochure and demo disk. And experience firsthand added SPICE and higher speed — on larger circuits.

spectrum

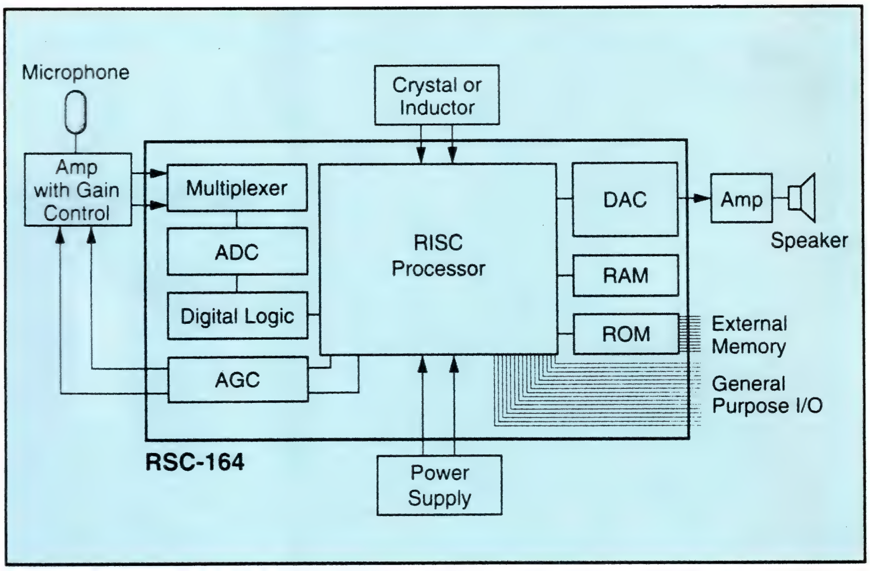
1021 S. Wolfe Road
Sunnyvale, CA 94086
(408) 738-4387 FAX (408) 738-4702

READER SERVICE 198

SINGLE CHIP EMPLOYS NEURAL-NET ALGORITHMS TO RECOGNIZE, SYNTHESIZE SPEECH

DAVE BURSKY

The RSC 164/264 combines an 8-bit RISC processor with neural-net algorithms for speech recognition, while using the RISC engine to perform high-quality speech synthesis and system control. The one-chip recognition/synthesis processor can thus perform speaker-independent speech recognition, as well as high-quality speech synthesis using a time-domain compression scheme that improves on conventional ADPCM. The RSC 264 is a full system on a chip with ROM, RAM, 16 general-purpose I/O lines, a-d and d-a converters and the dedicated 8-bit RISC processor. The RSC 164—basically the same chip—also has an interface to off-chip memory for development or extended vocabulary.



The highly-integrated chips, which sell for as little as $3.25 apiece, trim the system cost because all that's needed to supplement the chip are a microphone, input amplifier, speaker, output amplifier, a few switches, and the batteries and pc board (less than $2. in additional components). Furthermore, the use of neural-net algorithms lets the circuits achieve accuracy levels comparable to chips costing many times that of the RSC devices.

Built in CMOS, the chips also include a power-down mode to help minimize power drain—the chip draws less than 10 μA of standby current. Dual on-chip oscillators include a 32.7-kHz oscillator for operation from inexpensive watch crystals, and another oscillator for use with standard high-frequency crystals. Automatic gain control is also included on the RSC chips to compensate for people not optimally positioned with respect to the microphone or those who speak too softly or loudly. The on-chip memories provide enough storage for over 40 seconds of high-quality speech or sound effects. And the RISC processor, with its roughly 4 MIPS throughput, can recognize vocabularies of hundreds of words, which would typically be organized in nested menus of 2-10 words each. The short menus reduce the search time and improve the recognition accuracy. On-chip digital filtering helps improve the overall accuracy of the recognition by preprocessing the signals. Larger menu vocabularies can also be used, however word selection must be done carefully to minimize the use of similar-sounding words in the same menu.

The neural algorithms and synthesis can be used in tandem to provide verification of a partially recognized word. For instance if the chip should fail to recognize a word, the algorithms could assign weighting factors to set up a most-likely response or a totally unrecognized response and then have the synthesis function respond with a question, asking the speaker to verify the spoken word either by repeating if it wasn't recognized or answering yes or no if the system guessed at the word.

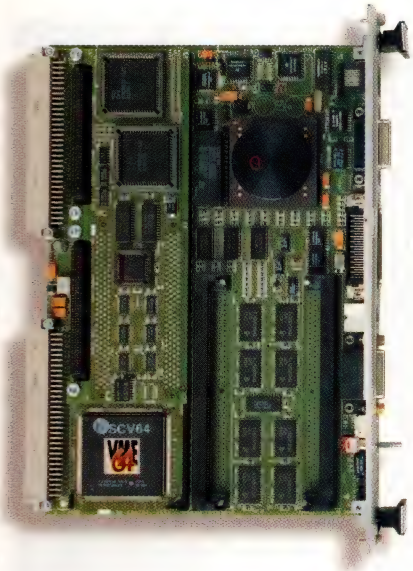
The algorithms employed in the neural-network by Sensory perform the word classification—they classify the sound as belonging to one of the possible words within a set of words. The network is trained by a supervised learning paradigm—it is provided with a set of examples of categorized sounds, and the connection strengths between units are adjusted to produce the appropriate category response to each of the training examples. If the network has learned well, it will then be able to generalize and classify novel examples of words correctly.

The neural network used by Sensory is structured to perform Bayesian classification. Thanks to the use of an explicit probabilistic model in the network, prior class probabilities can be incorporated and the network outputs can be interpreted as a probability distribution over classes. The training procedure explores the space of neural network models as well as weighting coefficients; cross-validation techniques are used for model selection. A cross section of between 300 and 600 voice samples is used to provide a broad cross-section of typical speakers.

Sensory also created a vocabulary-development environment for recognition or synthesis. Custom ROM data can be encoded for a masking charge of $3500; vocabulary-development charges start with a base fee of $2500 and $250/word for recognition, and $500 per recording session plus $50 to $100/word for synthesis. Royalty-free sound effects are available for $100/s. The RSC 264 costs $3.25 each in large volumes—the RSC 164 is about $0.50 more per chip. Samples are available now.

***Sensory Circuits Inc.**, 1735 N. First St., Ste. 313, San Jose, CA 95112-4511; Todd Mozer, (408) 452-1000.* CIRCLE 843

IT'S ABOUT TIME



Finally, SPARC on VME64!

The SPARC®5/64 Doubles Your VME Performance.

The Wait is Over

Now, with the SPARC 5/64, the first SPARC VME64 Engine, you've got the throughput you've been waiting for to integrate power-hungry systems like array processors and high-end graphics engines. No more headaches from bumping your head on the performance ceiling.

It's About Performance

The SPARC 5/64's 64-bit wide data path gives you twice the bus bandwidth of VME32 platforms. With VME burst rates up to 38 Mbytes/sec. your data simply flies.

An 85 MHz microSPARC II processor, the newest, fastest member of the microSPARC family, paces this double wide bus with 64 SPECint92 and 54.6 SPECfp92 performance.

With a design licensed from Sun Microsystems, our 6U VME64 engine is a faithful VMEbus extension of Sun's SPARCstation™5. The result is 100% compatibile SPARCstation 10/51-class performance.

It's About Time to Market.

In this world time is of the essence. Themis makes it easier for you with products that are ahead of their time. Give us a call and find out more about how we put innovation and imagination to work for you.

- **100% SPARCstation™5 Compatible**
- **85MHz microSPARC II**
- **64 SPECint92/ 54.6 SPECfp92**
- **8 Mbytes to 128 Mbytes DRAM with SIMM Upgrades**
- **Up to 1 Mbyte Flash Memory (optional)**
- **Ethernet/SCSI II-FAST**
- **Two Serial Ports**
- **Two SBus Slots**
- **Centronics Port**
- **Keyboard/Mouse Port**
- **Newbridge SCV64 VME64 Interface**
- **Solaris 1.1.1 and Solaris 2.3 Support**
- **VxWorks RTOS Support**

THEMIS COMPUTER

THEMIS COMPUTER
6681 Owens Drive
Pleasanton, CA 94588
Ph: 510/734-0870
Fax: 510/734-0873

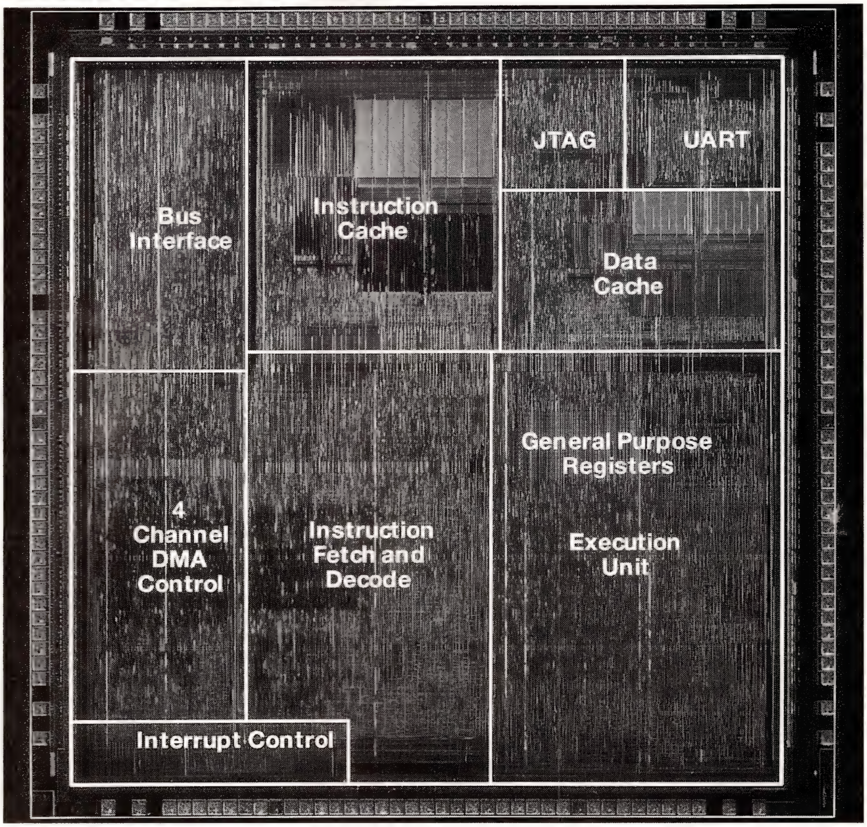
France:
Ph: +33.1.69.82.20.39
Germany:
Ph: +49.60.416510
U.K.:
Ph: +44.734.258.080
Asia:
Ph: +65.473.5702

READER SERVICE 199

SPARC®5/64 is a registered trademark of SPARC International, Inc. licensed exclusively to Themis Computer. All others are trademarks of their respective companies.

OPTIMIZED POWERPC RISC CONTROLLER INTEGRATES MANY FUNCTIONS

DAVE BURSKY



Although the basic architecture of the embedded PowerPC processor family was unveiled last April by IBM, the first of the PowerPC 400 series processors was released this month—the PowerPC 403GA. Operating at 25 MHz with 3.3 V, it dissipates only about 300 mW, typical (a few mW in standby), thanks to aggressive power management. Still, it delivers a high throughput—54.5 kDhrystones. By early 1995, IBM expects to release a 33-MHz version with up to 72 kDhrystones.

To deliver such high throughputs, the PowerPC core had to be redesigned from the ground up, while maintaining instruction compatibility with the PowerPC 600 series. The core implements an integer-only version of the PowerPC instruction set and does not include any memory-management logic. Supporting the core are 2 kbytes of instruction cache and 1 kbyte of data cache, both two-way set-associative, and a selection of commonly required peripheral-support functions.

Also included are a memory support controller for DRAM, SRAM, and ROM, a four-channel DMA controller, a six-input interrupt controller (external sources, one nonmaskable), a high-speed serial port (delivering bit streams at up to 1.5 Mbits/s), two general-purpose timers, and a watchdog timer. The DMA controller manages block data transfers in buffered, fly-by, and memory-to-memory modes. In fly-by and buffered modes, the DMA controller supports transactions between memory and peripheral devices. DMA channel 0 also supports DMA chaining.

The multi-input interrupt controller has a low latency for quick response to interrupts—just three cycles, typical, 37 cycles, worst case, including cache-miss effects. Four timers—a time base, a programmable interval timer, a fixed-interval timer, and a watchdog timer—are provided by the timing block. The triple-level metal, 0.5-µm CMOS IC is just 6.2 by 6.3 mm and is one of the most cost-effective high-performance embedded controllers. The chip's superscalar architecture implements an integer version of the PowerPC instruction set. Floating-point operations are thus performed with software emulation. Instruction queue logic manages branch prediction, branch folding, and instruction prefetching to minimize pipeline stalls. Most instructions execute in a single cycle, with the exception of the Load/Store Multiple, Load/Store String, Multiply, and Divide instructions. There's also a hardware multiplier and divider to speed integer arithmetic.

External I/O devices or SRAMs/DRAMs can be directly attached to the bus-interface block. Up to eight memory banks and I/O devices, including up to four DRAM banks, can be configured individually, allowing the bus interface block to manage devices or memory banks with differing control, timing, or bus-width needs. The processor can effectively address up to 4 Gbytes, mapped into a 3.5-Gbyte physical address space (256 Mbytes for SRAM/ROM, or other I/O; 256 Mbytes of DRAM; and 3 Gbytes through the on-chip peripheral bus). That space is further logically divided into 28 regions of 128 Mbytes each. Besides being supported by all PowerPC development tools for the 600 series, a real-time operating system available for the 600 series is also available for the 403GA. Additional software support will be available from over 20 software and tool suppliers. A separate JTAG test/debug port allows the processor to be tested in the system as a stand-alone element or part of a chain of devices. Also available from IBM is an evaluation kit—the $2450 RISCWatch400—and a $14,500 hardware debugger. The processor comes in a 160-lead PQFP and costs $48.91 each in 1000-unit lots. Delivery of samples is from stock.

IBM Microelectronics Inc., *PowerPC Embedded Solutions, 3039 Cornwallis Road, Research Triangle Park, NC 27709; Tami Spaulding, (919) 543-1546.* **CIRCLE 844**

■ *DAVE BURSKY*

ALLIED ELECTRONICS SUPERHIGHWAY!

Same day shipment

ow, with an expanded computer system, a national communication network and much more inventory on-line, the Allied perhighway is serving our customers better than ever before. Two computer systems in one gives you instantaneous -line access to more than 90,000 Allied parts as well as hundreds of millions of dollars of Avnet inventory.

● And once you're on our superhighway, you have computerized records of past transactions and up-to-the-moment information on the status of orders, billings and back-orders. Processing for same-day shipment begins the instant an order is entered. And payment is simple. Put it on a credit card, an Allied account or just pay COD. ● In an environment where time-to-market and up-time often mean the difference between survival and extinction, we put you on the fast track against your competition.

MULTIMEDIA Ours is the industry's first multimedia catalog. You choose between the traditional printed catalog or an easy-to-access CD-ROM complete with thousands of pages of specification data, charts, tables, drawings and even photographs. The information on the part you want is no more than a mouse click away.

ALLIED IS DIFFERENT The computer systems, a communication network linking our more than 80 sales offices, a multimedia catalog – everything that makes up the Allied Superhighway is there for our sales professionals to solve your problems and assure each order is accurately filled and delivered on time. ● Call today to have the Allied Electronics Superhighway brought right to your door.

More than 80 local sales offices

Multimedia catalog on CD-ROM

ALLIED ELECTRONICS INC.
AN AVNET COMPANY

Going by the book...And beyond!
1-800-433-5700

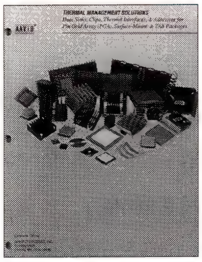
CIRCLE 228

CATALOG/LITERATURE REVIEW

Heat sinks for microprocessors

New 36-page catalog covers heat sinks, clips, double-sided tapes, adhesives, thermal interface materials, and fan heat sinks for cooling CPUs in PGA, surface mount and TAB packages. Contains CPU heat sink selector guide.

Call 603-528-3400.

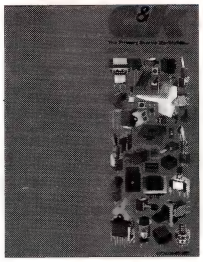


CIRCLE 721

AAVID ENGINEERING, INC.

C&K's New Switch Catalog

Offering the broadest line of switch products, C&K's new Catalog #9308 provides valuable design information for wide range of applications. Complete photo descriptions and specifications, along with electrical ratings, mechanical ratings, mechanical operation characteristics are included.

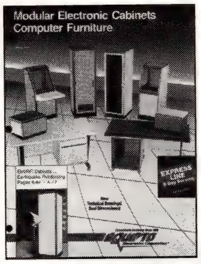


CIRCLE 722

C&K Components, Inc.

Much New In Free Enclosures Catalog

More EMI/RFI shielded cabinets are offered. Shielding effectiveness test data have been revised. Earthquake reinforced enclosures have been added. New, too are dual dimensioned technical drawings in this over 300-page free catalog on modular cabinets, and computer furniture



CIRCLE 723

EQUIPTO ELECTRONICS

KEPCO POWER SUPPLIES

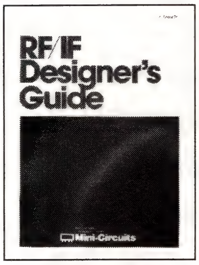
Kepco's new 1994 Catalog/Handbook on digital & analog instrumentation & modular power supplies offers many new control options to Automatic-Test systems designers including: VXI, RS 232, IEEE 1118 (serial bus) & IEEE 488.2 (SCPI); wideband analog-programmable supplies may be used as power amplifiers.

CIRCLE 724

KEPCO, Inc.

RF / IF Designer's Guide Released

New.....The latest edition of Mini-Circuits 128 page Designer's Guide is now available featuring comprehensive product listings and specifications for over 1,000 standard RF / IF and microwave components from DC to 8 GHz. Mini-Circuits P.O. Box 350166 Brooklyn, N.Y. 11235-0003 Phone: 718-934-4500 Fax: 718-332-4661



CIRCLE 725

Mini-Circuits

New Approach to Scientific Data Analysis

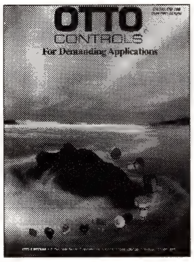
Analysis Advisor is a free interactive analysis software tutorial that includes demos of graphical and traditional programming methodologies for analysis. In using the tutorial, you can investigate Digital signal processing, Digital filtering, Windowing, Curve fitting, Signal averaging, Simulation, interpolation, and more. Require Windows 3.1 and 8 MB of memory.

CIRCLE 726

National Instruments

Snap-Action Switches

All new Catalog 105 has 72 pages featuring the new sealed rocker K Series and detailing an in-depth line of precision snap-action pushbutton, toggle, rocker, limit and basic switches. All feature OTTO's unique design assuring low contact resistance, high contact pressure and long cycle life. Quality made in the U.S.A.

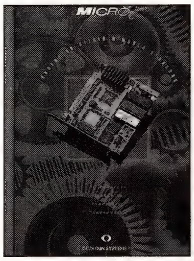


CIRCLE 727

OTTO CONTROLS

Embedded PC Catalog

Octagon System's, Westminster, CO, 112-page catalog displays their Micro PC® family. The Micro PC line is designed for apps. where small size wide temperature range, and rugged packaging are critical. ISO 9001 certified.



CIRCLE 728

OCTAGON SYSTEMS

Small Industrial Computers

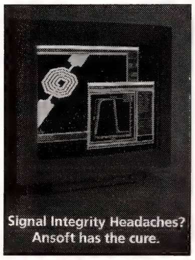
Brochure reviews STD 32, an 8-, 16-, and 32-bit industrial computer standard combining PC functionality and a compact format. A short form spec and list of manufacturers are included.

CIRCLE 729

SIG 32

Signal Integrity & EMI/EMC

Maxwell SI Eminence offers a unique, integrated solution to the whole spectrum of high speed design issues from signal delays to EMI/EMC. Characterize effects to analyze complex electronic designs.

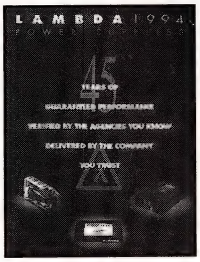


CIRCLE 730

Ansoft Corporation

POWER SUPPLIES

A new 168 page full line catalog is available on request from Lambda Electronics Inc., N.Y. . It contains detailed information and prices on over 1000 standard power supplies, systems and accessories including 200 new products.



CIRCLE 731

LAMBDA ELECTRONICS INC.

TRANSFORMERS, DC-DC CONVERTERS

Pico 136 page catalog features new 100 watt dual output DC-DC Converters Series plus other standard models up to 1000 VDC output voltages. Also included are thousands of surface mount transformers & inductors and an AC-DA Power Supply Section.

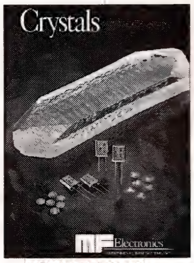
PICO
SURFACE MOUNT · PLUG-IN TRANSFORMERS & INDUCTORS
DC-DC CONVERTERS
AC-DC POWER SUPPLIES
HIGH POWER DC-DC CONVERTERS

CIRCLE 732

PICO ELECTRONICS INC.

CUSTOM FREQUENCY CRYSTALS

MF Electronics offers a new crystals brochure. Included is general crystal design information and quartz microprocessor and special crystal info. Detailed definitions and directions for selecting custom crystals are listed.



CIRCLE 733

MF ELECTRONICS CORPORATION

CRYSTAL OSCILLATOR CATALOG

Vectron has published its new 1994 Crystal Oscillator Catalog. The comprehensive catalog details vectrons complete product line including clock and sinewave oscillators, TCXO'S, OCXO'S. VCXO'S and Sonet CDR products.

CIRCLE 734

Vectron Laboratories

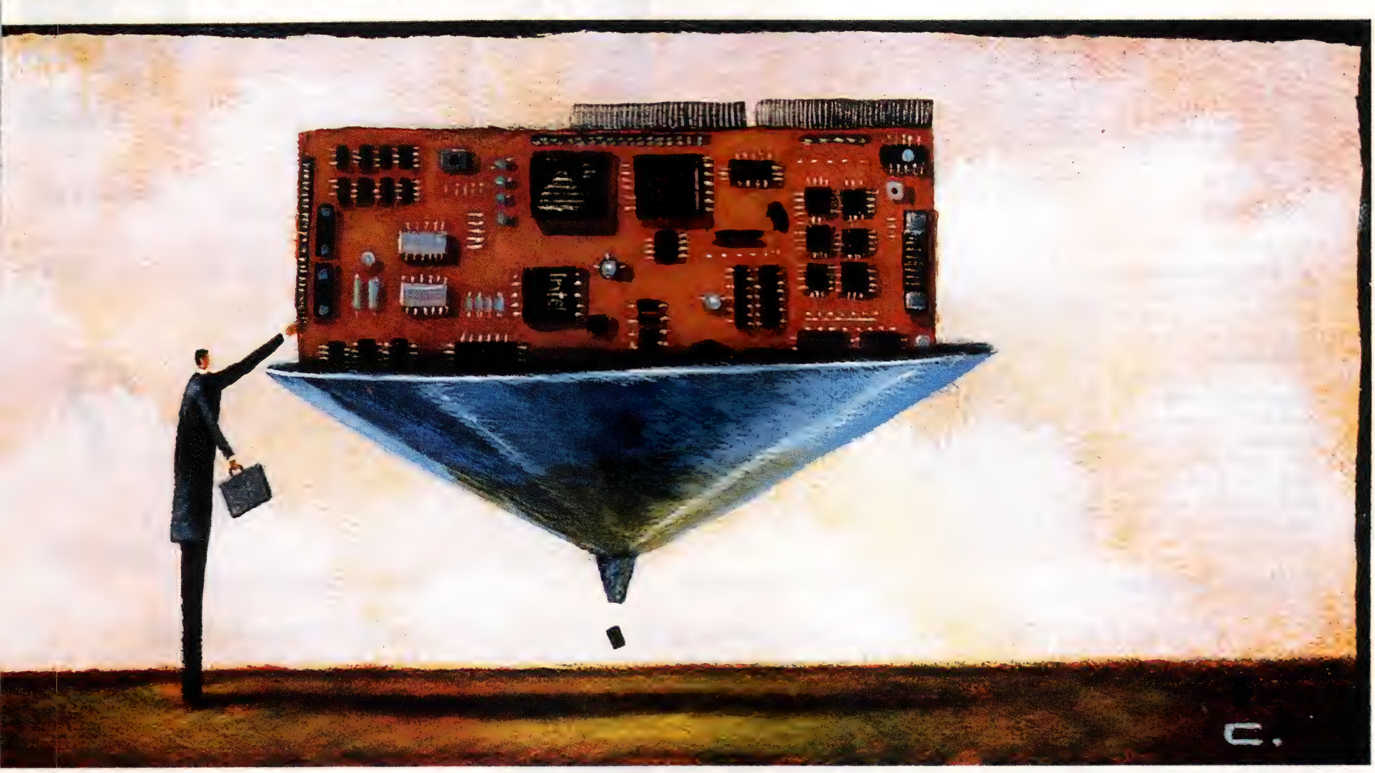
DSP and I/0 Boards/Systems

New 1994 catalog of digital signal processing boards, systems and software plus a full range of analog and digital I/O for VME, Sbus and PC/AT. Systems range from single DSPs to large-scale parallel processor solutions.

CIRCLE 735

ARIEL CORP.

It's got to be simpler.
It's got to be faster.
It's got to be more highly integrated.



OTE DATA LOGGING   POWER METERING   PROCESS CONTROL   HANDHELD INSTRUMENTATION   PORTABLE MEDICAL DIAGNOSTICS

It's got to be Crystal.

Crystal's SMART *Analog*™ ADCs mean simpler, faster designs—crucial parameters when your system has to master real-world applications today.

Specifically, Crystal Semiconductor's 5504 series of delta-sigma A/D converters has revolutionized the data acquisition industry. These highly integrated chips are key to reducing design time, increasing performance, lowering costs and still getting to market first.

The 5504 series features Crystal's proven SMART *Analog* approach to delta-sigma technology, which reduces external component requirements to near zero. On-chip digital filtering delivers clean signal processing. And the 16- or 20-bit resolution delivers higher accuracy. Much higher.

There's a full range of solutions, including on-chip instrumentation amplifier and multiplexers allowing up to 200 samples/second per channel. And the lowest power, smallest package, lowest cost 16-bit chip.

Call now for more information on the 5504 series and evaluation kit: 1-800-888-5016 (or 1-512-445-7222). See why it's got to be Crystal's ADCs for your data acquisition design project.

For real-world demands, it's got to be the 5504 series.

	Resolution (bits)	Number of Channels	Output Update Rate (samples/sec.)
CS5504	20	2	20/200
CS5505	16	4	20/100
CS5506	20	4	20/60
CS5507	16	1	20/100
CS5508	20	1	20/60
CS5509	16	1	20/200

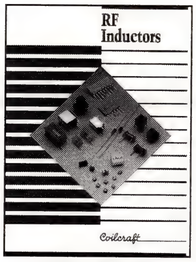
CRYSTAL
A Cirrus Logic Company

1-800-888-5016 ■ 1-512-445-7222

CIRCLE 231

RF INDUCTORS

Coilcraft is offering a new RF inductors catalog showing their range of products for the RF engineer. It includes detailed specs on Coilcraft's surface mount inductors, tuneable and fixed inductors, wideband RF transformers, and L/C filter networks. Also featured is a range of designer's kits filled with sample parts to simplify prototyping.

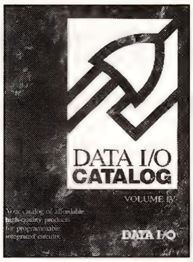


CIRCLE 736

COILCRAFT

MADE TO ORDER

The Data I/O catalog makes our affordable tools easy to order. Phone, Fax, or mail in your order, and we'll deliver great values on high-quality design software and device Programmers. Call today for your FREE catalog.

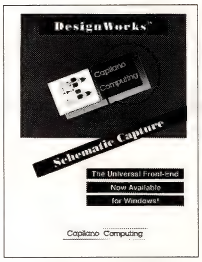


CIRCLE 737

DATA I/O CORPORATION

SCHEMATIC CAPTURE

This brochure details DesignWorks for Windows, the universal front end for use with PCB, FPGA, ASIC and SPICE packages. Software features full hierarchy, automatic gate packaging and 13,000 + symbols.

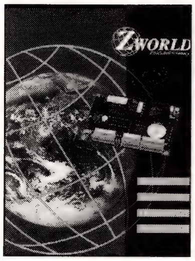


CIRCLE 738

Capilano Computing

C-Programmable Controllers

Save time and money. Our controllers are ideal for control, test or data acquisition applications with a mix of analog/digital I/O, relays, RS232/485 serial ports, LCD/keypads, & programmed with Dynamic C™. From $159, Qty. 1. (916) 757-3737, or Fax: (916) 753-5141. For 24 Hr. data, call from YOUR Fax: (916) 753-0618.

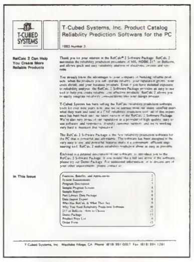


CIRCLE 739

Z-World Engineering

Reliability Prediction

Catalog describes the RelCalc2 software Package, which automates Mil-HDBK-217 or Bellcore on your PC, and allows quick and easy reliability analysis of your electronic products. Phone: (818) 991-0057 Fax: (818) 991-1281


T-CUBED SYSTEMS
T-Cubed Systems, Inc. Product Catalog
Reliability Prediction Software for the PC

CIRCLE 740

T-Cubed Systems

YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

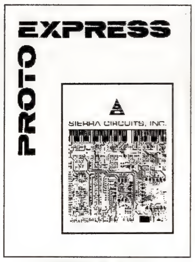
?

CIRCLE 741

YOUR COMPANY NAME

PROTO EXPRESS

Multilayer prototypes in 1 to 5 days. FR4 and polyimide. Commerical or Milspect capabilities *buried/blind VIAS* carbon paste* up to 22 layers. Call Ken or Joycie 408-735-7137 phone 408-735-1408.

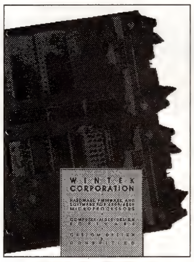


CIRCLE 742

Proto Express

Microcomputer Modules & CAD

The catalog describes 6800 and 6809 single-board computers, input/output interfaces debuggers, compilers and assemblers; plus schematic capture and printed circuit board layout software and accessories for the IBM personal computer.



CIRCLE 743

Wintek Corporation

DEVICE PROGRAMMERS

Affordable, dependable & versatile, Advin offers a full line of device programmers. All pkg types supported. IC mfrs approved. Free lifetime s/w updates via electronic BBS. Call for free catalog & latest supported devices list.

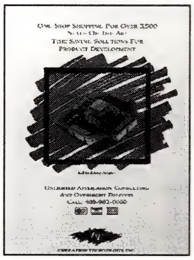
PILOT Programming Instruments.
Finest Quality at Affordable Prices.
Advin Systems Inc.

CIRCLE 744

Advin Systems Inc.

VLSI/SMT SOLUTIONS CATALOG

Free '94 catalog. Over 3500 devices; 120 "off-the-shelf" items available for overnight delivery. Unlimited application consulting. Ask about our custom designs. Leading edge technology —over 500 PQFP Solutions. Time Saving Solutions.

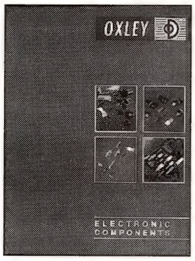

One Stop Shopping For Over 3500
State Of The Art
Time Saving Solutions For
Product Development
Unlimited Application Consulting
And Overnight Delivery
Call: 408-982-0660

CIRCLE 745

EMULATION TECHNOLOGY

ELECTRONIC COMPONENTS

1994 Catalog contains technical info on our full range of components which include: EMI/TVS Filters, Planar Arrays, Trimmer Capacitors, Led Indicators NVG Displays, Elapsed Time Indicators, Test Points for pcbs, fiber optics.

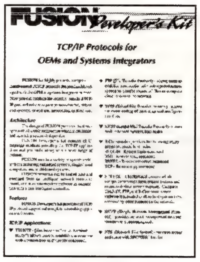


CIRCLE 746

OXLEY INC.

TCP/IP DEVELOPER KITS

Fusion is a Highly Portable set of TCP/IP protocols with the OEM or systems integrator in mind combine industry standard TCP/IP suite with your embedded system also available SNMPV.2 Network management agent code.



CIRCLE 747

Pacific Softworks Inc. sltl

YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

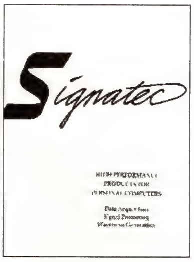
?

CIRCLE 748

YOUR COMPANY NAME

Highspeed Waveform Capture

Signatec, Corona, CA. - A binder containing data sheets for all of its pc based products for use in the areas of waveform capture, waveform generation and signal processing can be obtained by contacting them at (909) 734-3001

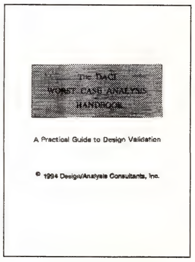


CIRCLE 749

Signatec Inc.

DESIGN VALIDATION

Use DACI's Handbook to achieve reliable, cost effective, optimized designs, without the need for complex math.
$49/Copy (Free with purchase of DACI's Worst Case Analyzer software.)


The DACI
WORST CASE ANALYSIS
HANDBOOK
A Practical Guide to Design Validation
© 1994 Design/Analysis Consultants, Inc.

CIRCLE 750

Design/Analysis Consultants, Inc.

COMPLIMENTARY ISSUE!

Let us deliver the world of *Electronics* to your desk

The global electronics executive's indispensible source for industry news, trends and analysis in key markets:

COMMUNICATIONS

SEMICONDUCTORS

COMPUTERS

TRADE

- Telecommunications
- Semiconductors
- Computers
- International trade

☐ **YES!** Send me my **FREE** issue of ***ELECTRONICS*** and enter my 1-year subscription, 23 issues—**for 10% off the regular subscription rate!** If I choose not to subscribe, I'll simply write "cancel" on the invoice and return it. The free issue is mine to keep.

One year subscription rates (U.S. funds drawn from a U.S. bank):

☐ U.S. ~~$98~~ $88 ☐ Canada ~~$120~~ $108 (plus GST) ☐ Other Countries ~~$190~~ $171

Please bill my credit card: ☐ Visa ☐ MasterCard ☐ AMX ☐ Discover

Card No. ____________________ Exp. Date ____________________

Signature ____________________ Date ____________________

Name ____________________ Title ____________________

Company ____________________

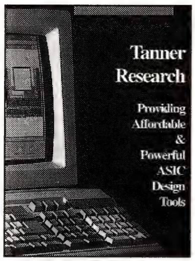
Mailing Address ____________________

Order by FAX: 216/696-6413 or call 216/696-7000, x 4137

1EDh4c

ASIC Design Software

Tanner Research, Pasadena, Calif., has a new brochure with detailed information on its complete line of affordable CAE/CAD software for ASIC design and layout. A free demo disk and price list are included.



CIRCLE 751

TANNER RESEARCH

YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

?

CIRCLE 752

YOUR COMPANY NAME

Design Tools with Power

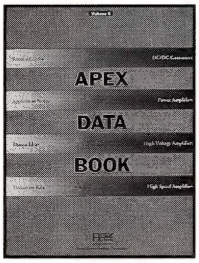
FREE detailed specifications and full-function software evaluation packages are available for all Tango and TangoPRO products, inicluding Schematic, PCB design, and autorouting software. Call now at 1-800 488-0680.

CIRCLE 753

Accel Technologies, Inc.

DC/DC Converters

More than 80 models of power amplifiers, Apex Microtechnology's 6th edition DC/DC Converts, Power & HV Amplifiers Data Book & Application Notes contains 25 application specific app notes. These notes provide technical assistance for circuit design. Call 1-602-690-8608, Fax 1-602-888-3329.

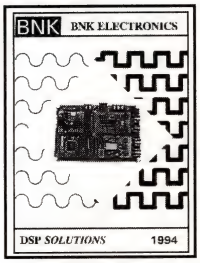


CIRCLE 754

Apex Microtechnology Corp.

New Low Cost DSP Systems

Low-cost high-performance compact modular PC-based digital signal processing boards, systems & software + analog & digital I/O modulars. Line of PC-based networkable external real-time data acquistion & processing systems.

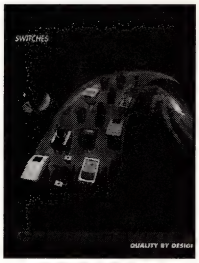


CIRCLE 755

BNK Electronics, Inc.

NEW SWITCH CATALOG

New Carlingswitch catalog lists complete line of rocker, toggle pushbutton and rotary switchers. Wide variety of circuits; ratings to 100 amps. Easy-to-use ordering form ats, switch specs, and photos given.

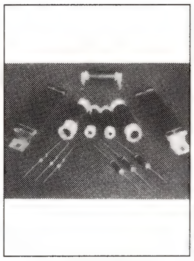


CIRCLE 756

Carlingswitch, Inc.

Ceramic Resistors

Globar Type SP Non-Inductive Bulk Ceramic Resistors from CESIWID outperform conventional wire-wound and film resistors under short-term overload and transient conditions. SP resistors available in many shapes and terminations and custom products are available to meet specific requirements.

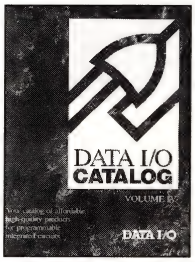


CIRCLE 757

CESIWID

Made to Order

The Data I/O catalog makes our affordable tools easy to order. Phone, Fax, or Mail in your order, and we'll deliver great values on high-quality design software and device programmers. Call today for your FREE catalog.

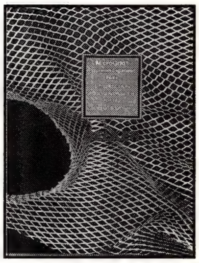


CIRCLE 758

Data I/O Corporation

Precision Expanded Foils

Microgrid precision expanded metal foils shield EMI/RFI and conduit electricity / heat. Lightweight, flexible, uniform material bends, folds, & laminates.

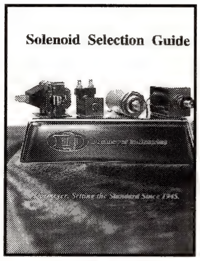


CIRCLE 759

The Delker Corporation

Solenoid Selection Guide

Dormeyer's C-frame, box-frame, tubular, and laminated linear solenoids are pictured and dimensioned for easy reference in this design tool / color brochure for solenoid applications. The solenoids are arranged by parameters such as pull-force, stroke length, voltage, duty cycle, and termination style to help assure the correct solenoid application.

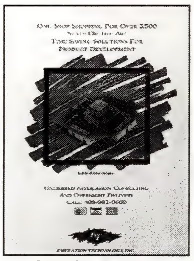


CIRCLE 760

Dormeyer Industries

VLSI / SMT Solutions Catalog

FREE '94 catalog. Over 3500 devices; 120 "off-the-shelf" items available for overnight delivery. Unlimited application consulting. Ask about our custom designs. Leading edge technology --over 500 PQFP solutions. Time saving solutions.



CIRCLE 761

Emulation Technology

Miniature Connectors

HARTING har-mik catalog shows and describes comprehensive range of miniature connectors designed to meet the requirements of Internal and External connections of the future. Reduced size: contact pitch of 1.27mm, High contact density. 708/ 519-7700 or FAX 708/ 519-9771.

CIRCLE 762

HARTING ELEKTRONIK, INC.

Mil-Std-1553, SSPCs, MCMs

National Hybrid Inc., Ronkonkoma, N.Y., A mil-std-1772 certified & qualified manufacturer, has released its new product catalogs. Featuring leading edge solutions for 1553/1760 Databus, solid state power control, & mulichip module applications.

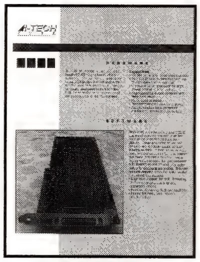
NATIONAL HYBRID, INC.
** New Product Information **
Mil-Std-1553/1760
Solid State Power Controllers
Ceramic Multichip Modules
June 1994
In Order of Appearance:

CIRCLE 763

National Hybrid Inc.

IPC-6020 SCSI-3 WIDE Tester

This 16-bit SCSI Emulation Test System provides an unsurpassed combination of hardware capability, software features and price, making I_TECH the best choice for SCSI emulation testing. The IPC-6020 comes with an Interactive Menu, a professional set of Compiled Tests and a linkable library of SDS-compatible test functions. 4-color data sheet available.

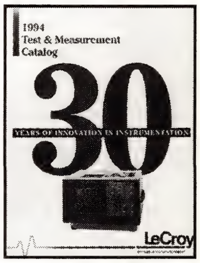


CIRCLE 764

I-Tech Corp.

LeCroy Offers New T&M Catalog

New 1994 Catalog, featuring product information, selected applications information and a Fundamentals of Digital Oscilloscope tutorial. The applications supplied illustrate the use and applicability of LeCroy products in a variety of disciplines. Catalogs are available through LeCroy's Customer Care Center, call 1-800-4-LeCroy (1-800-453-2769).

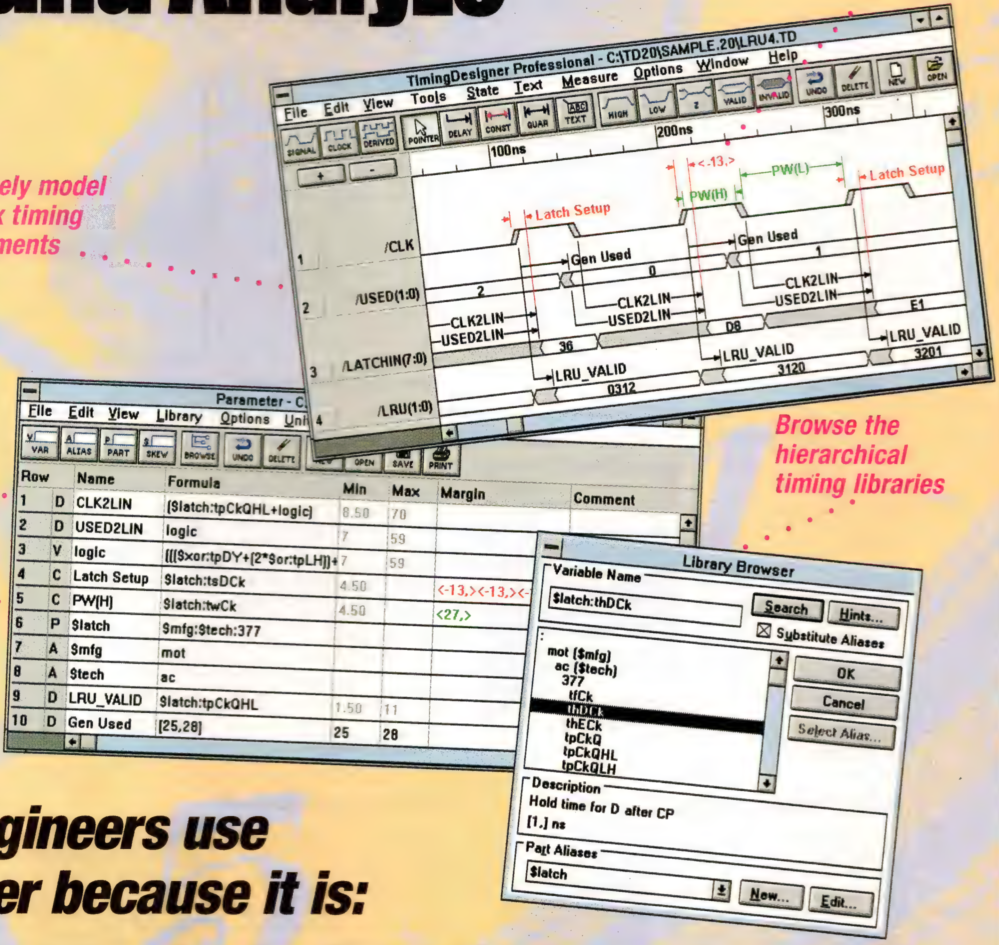


CIRCLE 765

LeCroy Corporation

NOW SHIPPING VERSION 2.1 for WINDOWS™ and UNIX

TimingDesigner®...
The Best Way to Specify and Analyze Timing



Row		Name	Formula	Min	Max	Margin	Comment
1	D	CLK2LIN	[$latch:tpCkQHL+logic]	8.50	70		
2	D	USED2LIN	logic	7	59		
3	V	logic	[([$xor:tpDY+[2*$or:tpLH]]+	7	59		
4	C	Latch Setup	$latch:tsDCk	4.50		<-13,><-13,><-	
5	C	PW(H)	$latch:twCk	4.50		<27,>	
6	P	$latch	$mfg:$tech:377				
7	A	$mfg	mot				
8	A	$tech	ac				
9	D	LRU_VALID	$latch:tpCkQHL	1.50	11		
10	D	Gen Used	[25,28]	25	28		

Library Browser

Variable Name: $latch:thDCk

☒ Substitute Aliases

mot ($mfg)
  ac ($tech)
    377
      tfCk
      thDCk
      thECk
      tpCkQ
      tpCkQHL
      tpCkQLH

Description: Hold time for D after CP
[1,] ns

Part Aliases: $latch

Instantly compute critical path margins

Accurately model complex timing requirements

Changes to timing parameters instantly update diagram

Automatic part swapping

Browse the hierarchical timing libraries

Over 5,000 engineers use TimingDesigner because it is:

the best way to create and analyze timing diagrams

the best way to compute worst-case timing margins

the best way to instantly see the effects of design tradeoffs

the best way to analyze the interface between complex chips

the best way to visualize timing relationships in complex clock trees

the best way to communicate timing specifications to other designers

CIRCLE 237

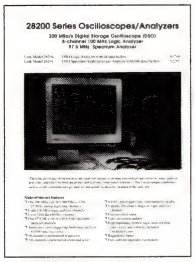
Call today for a FREE evaluation kit! **800-800-6494**

CHRONOLOGY®

Chronology Corporation 17411 NE Union Hill Rd #100 Redmond WA U.S.A. 98052
Telephone (206) 869-4227 FAX (206) 869-4229 EMAIL chronco!sales@uunet.uu.net
FAX us for a list of our European distributors

200MSa/s Digital Scope

Link Instruments' Series 28000 PC Based DSO/Logic Analyzers consist of a dual-channel, 125MHz bandwidth, 200MSa/s scope and an eight channel 100MHz logic analyzer on a single PC board. A spec sheet details the scope boards.



CIRCLE 766

Link Instruments, Inc.

Device Programming Tools

The newest advances are presented in over 20 pages, illustrating the widest sellection of development and production tools, PLO / FPGA design software, UV erasers, and PROM / PLD programmers from the leading manufacturer.

CIRCLE 767

Logical Devices, Inc.

Precision Oscillators

Catalog describes SMD and DIL clock oscillators, voltage controlled oscillators, and over controlled oscillators. The products feature extended operating temperature range.

CIRCLE 768

Micro Crystal

Memory Card Interconnect Systems

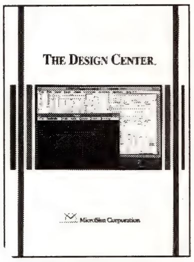
Meritec 50 position Memory Card Interconnect Systems provide I/O access to Elco card frames. Each system consists of an I/O card connector, which mounts to an Elco card frame, and a mating ribbon cable assembly. In addition to Elco frames, the systems can be made to fit other manufacturers' frame configurations.

CIRCLE 769

MERITEC

Design Center EDA System

With MicroSim's Design Center, select from schematic entrys, circuit simulations, programmable logic synthesis, analog performance optimization, and signal integrity analysis to build a custom integrated analog, digital, or mixed analog/digital desktop EDA system.

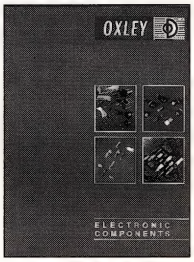


CIRCLE 770

MicroSim Corporation

Electronic Components

1994 catalog contains technical information on our full range of components which include: EMI/TVS filters, Planar Arrays, Trimmer Capacitors, LED Indicators, NVG Displays, Elapsed Time Indicators, Test points for PCBS, & fiber optics.

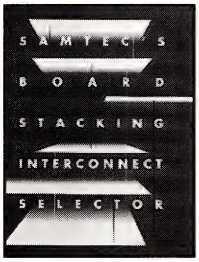


CIRCLE 771

Oxley Inc.

Board Stacking Interconnect Selector

Samtec's Board Stacking Interconnect Selector has been expanded with a 6th edition. This new edition includes new surface mount, 1mm and .050" micro pitch interconnects. They are arranged by board spacing to quickly identify a choice of interconnect solutions for each application. For information call, 800-Samtec-9. Fax 812-948-5047.



CIRCLE 772

Samtec, Inc.

Highspeed Waveform Capture

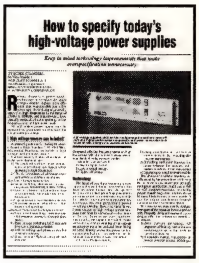
Signatec, Corona, CAE binder containing data sheets for all of its PC based products for use in the areas of waveform capture, waveform generation and signal processing can be obtained by contacting them at (909) 734-3001

CIRCLE 773

Signatec Inc.

HIGH VOLTAGE POWER SUPPLIES

In a four page tutorial, Spellman describes technology improvments that make over-specification of high voltage power supplies unnecessary find out how to select right parameters for your particular high voltage application!

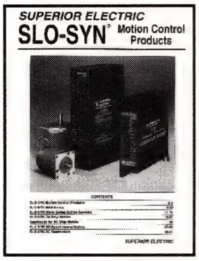


CIRCLE 774

Spellman High Voltage

MOTION CONTROL PRODUCTS

SLO-Syn Motion Control Product Guide has condensed descriptions and ratings of complete Superior Electric motion control line. Includes SLO-Syn Series 2000 drives, oscillator / analog speed followers and programmable motion controls; Micro Series translator drives, translator / oscillatos, preset and programmable indexers; Reference overview. 1-800-447-7171.

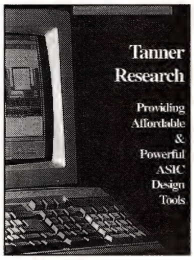


CIRCLE 775

Superior Electric

ASIC Design Software

Tanner Research, Pasadena, Calif., has a new brochure with detailed information on its complete line of affordable CAE/CAD software for ASIC design and layout. A free demo disk and price list are included.

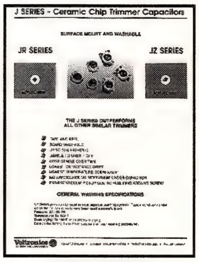


CIRCLE 776

Tanner Research

Trimmer Capacitors

Here is a brochure describing the best surface mount chip size trimmer capacitors available. They are sealed and washable. Complete technical data include charts of Q versus frequency to 1.5GHz, self-resonant frequencies for all parts, washing specifications and more.



CIRCLE 777

Voltronics

YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

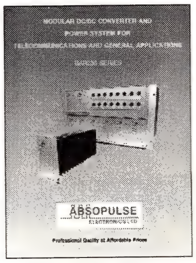
?

CIRCLE 778

YOUR COMPANY NAME

Battery Chargers

The PFC Rectifier delivers 500W to load or Battery (2500W per rack), Features include full electronic protection, redundancy, high MTBF and hot swapping. The series is available in rack mount or stand-alone format.



CIRCLE 779

Absopulse Electronics

YOUR CATALOG COULD BE HERE

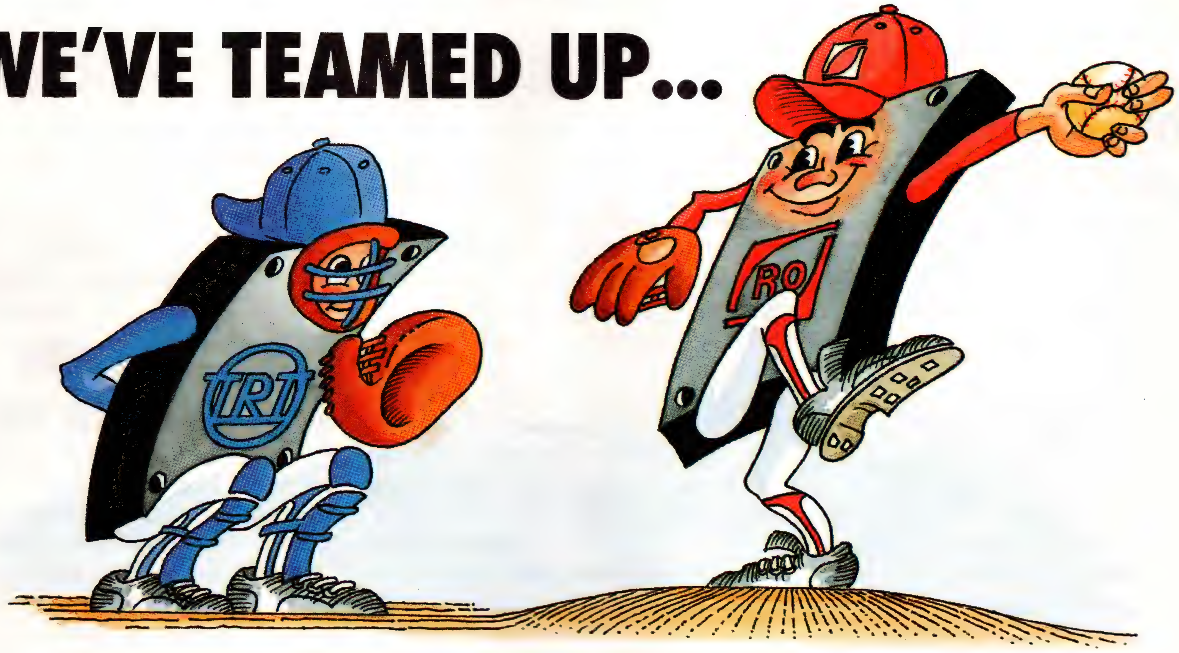
For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

?

CIRCLE 780

YOUR COMPANY NAME

WE'VE TEAMED UP...



FOR A WHOLE NEW BALL GAME IN DC-DC CONVERTERS.

WORLD'S MOST ADVANCED DC-DC CONVERTERS.

- Miniature Size – Up to 58 W/In.^{3}
- Up to 250 Watts Per Module
- 12/24/28/48/270/300 VDC Inputs
- Single and Triple Outputs
- Parallelable with Current Sharing
- FAULT-SAFE™ Power
- N+M Redundancy - No Single Point of Failure
- Hot Plug-in Capability
- 2nd Sourcing - Independent Manufacturers
- >1 Million Hours MTBF per MIL-HNBK-217E
- Non-Shutdown OVP
- Constant Frequency Operation
- Output Good Signal
- Optional Synchronization

NEW AUTOMATED PRODUCTION FACILITIES DELIVER HIGH VOLUME AT LOW PRICES.

RO has a new automated production line in Sunnyvale, CA. TOHRITSU's fully automated production facilities can deliver 100's of thousands of units per month. ***All units are full-featured – No stripped down economy models.*** Customers are invited to visit both facilities.

WE'LL DELIVER ONE OR ONE MILLION

Deliveries of low and medium quantities will be made by RO and higher volume requirements by TOHRITSU. The transition can be as transparent as desired.

LET'S PLAY BALL.
CALL TODAY FOR A QUOTE.
800-443-1450

RO

TRI

RO ASSOCIATES
SINCE 1963

TOHRITSU CO.
SINCE 1952

246 Caspian Dr., P.O. Box 61419
Sunnyvale, CA 94088
Tel: 408/744-1450
Fax: 408/744-1521

READER SERVICE 238

DEEP SUBMICRON DESIGN: CHANGES IN THE WIND?

I read with interest the letter to the editor you published on June 27 from Mike Keating and Dave Allenbaugh of Zycad Corp. It commented on your May 2 editorial titled "Paradigm Shuffle."

To my mind, the folks at Zycad are proving the point for change. They see the need of change and they are decoupling the problem to provide a solution. They state: "We then use synthesis to generate a gate-level representation of this system which is verified to be functionally equivalent to the RTL representation. The functional correctness of the system is verified at the behavioral and RTL level. To ensure a correct implementation, the gate level design must also be verified for functional equivalence to the RTL and behavioral levels."

They use RTL and behavior for design. They use gate level to ensure that the synthesis has done its job. Thus, it is a checking function to ensure that synthesis hasn't messed up. When formal verification comes along (Chrysalis and the like), that role will be removed.

One could also argue that if the synthesis tool were a compiler that went directly to transistors, that need again gets removed. They have decoupled timing analysis so it doesn't matter to them whether they use gate level or transistor level.

I would argue with them about the power analysis at gate level, but that's small potatoes. They go on to say that "the major difficulty in creating ASIC designs that meet their intent will continue to be architectural in nature. We will continue to see the shift of verification cycles into higher levels of abstraction to ensure system correctness as early as possible."

Absolutely. As we get farther and farther away from the implementation specifics, there will be a natural shuffle just as in compilers. The designer then will go directly from RTL to a binary format. Why do you then have a gate level? What is it there for? On an advanced IC, there will be full custom blocks and synthesized blocks. The role of verification will be using formal/static methods so that gate-level simulation won't be required.

In summary, their approach decouples the problems and their focus is on the "intent" of the design. Gate level is reduced to the role of checking that synthesis hasn't got it wrong. Add this to the future PCB on the IC with synthesized and full custom logic side by side and I think that you have the complete picture of the paradigm shuffle.

SIMON NAPPER
VICE PRESIDENT, MARKETING
EPIC DESIGN TECHNOLOGY
SANTA CLARA, CALIF.

INFORMATION HIGHWAY IS NOT ALL HYPE

Jack Shandle's editorial, "Information SuperHypeway" (July 1994) prompted me to write about our experience in Texas.

There's a saying that if you build a highway, people will drive on it. Texas has adapted this idea to information technology and found that you if build an information infrastructure, people will use it.

According to the Texas Department of Commerce, TEXAS-ONE, a State of Texas lead proposal, has been awarded $2.5 million in the Technology Reinvestment Project competition. More than 2800 proposals requesting a total of $8.5 billion were submitted from teams of companies, universities, and state and local governments nationwide.

The Texas Open Network Enterprise, TEXAS-ONE, will serve small and medium-sized manufacturers in Texas by providing an electronic information network previously accessible only by large corporations able to afford infrastructure investment. TEXAS-ONE is a partnership led by Texas Department of commerce, the Microelectronics and Computer Technology Corp., the Texas Department of Information Resources, the Texas Innovation Network System, NASA's Mid-Continent Technology Transfer Center, and the University of Texas at El Paso.

TEXAS-ONE is a model of what can and needs to be accomplished as we grapple with the design and implementation of a national information superhighway.

JIMMY A. CASTRO
GREATER AUSTIN
CHAMBER OF COMMERCE
AUSTIN, TEXAS

THIS READER KNOWS A SPOOF WHEN HE SEES IT

Either one of your editors was taken in by a classic spoof, or he had his tongue firmly in his cheek when he wrote "Electronic Soundproofing" (ELECTRONIC DESIGN, *May 2, 1994, p. 8)*. The description is very much like a longer article in an April issue of one of the standard electronic journals of the time—possibly *Wireless World* (I wonder what became of *that*?)—in 1953 or 1954.

The system shown is designed to give a marvelous howl. One hallmark of a send-up is by putting the microphone directly in front of the speaker, and the "rod connecting one element of the tube through the tube enclosure directly to the diaphragm of the microphone." Operating on batteries is probably part of the joke, since vacuum-tube amplifiers that could produce serious audio energy needed a huge battery pack.

It's possible nowadays to do what this circuit claimed to do, but it's not easy. Getting the right frequency, phase, and amplitude takes signal-processing capability that wasn't around in 1954. One of the more intriguing specialty applications, developed by a British firm, is to mute the exhaust of large trucks.

I'm personally a bit skeptical about the feasibility of reducing noise in aircraft cabins, which you mentioned. That's because unless you can cancel the sound at its source, cancellation will be effective only at a certain location, and not throughout a large cabin. Perhaps it can be done with many distributed speakers; but the signal processing that's needed must be a bear, since all of the sources will interact and try to cancel one another.

C.R. CAVONIUS
INSTITUT FUR ARBEITSPHYSIOLOGIE
AN DER UNIVERSITAT DORTMUND
GERMANY

ELECTRONIC PRESSURE-MEASUREMENT SYSTEMS

A full-color product catalog from Pressure Systems, Hampton, Va., describes and illustrates a range of electronic pressure-measurement systems for manufacturing test, aerospace research, and other applications. The free catalog includes a description of PSI's technology, electronic pressure scanning, on which the company's range of measurement systems is based. It also includes details on key electronic pressure-scanning components, such as the silicon pressure sensor and online calibration. Each of PSI's major product lines is presented in detail, including the company's line of pressure scanners, such as the miniature ESP remote BP and rack mount S1600 scanners. The System 9000, PSI's response to the growing demand for small-scale, high-accuracy pressure sensing and data acquisition, is highlighted. Configuration diagrams show how the System 9000's modular subsystems network to provide economical measurement of pneumatic or all-media pressures, as well as analog and frequency signals. CM **CIRCLE 934**

ANALYTICAL INSTRUMENTATION

George Fischer Signet, Tustin, Calif., has a 20-page, full-color catalog that features a variety of transmitters, sensors, and controllers designed for ease-of-use in applications ranging from water treatment to chemical processing. Among the products is the new Intelek-Pro series of controllers for pH, ORP, and flow, and the company's new Compak housing design made from corrosion-resistant, glass-filled polypropylene. The company's products include a full range of plastic pipes, fittings, valves, tank linings, heat exchangers, flow and analytical monitoring, and process-control instrumentation. CM **CIRCLE 935**

JOINT CATALOG OFFERS SCAN-BASED PRODUCTS

Corelis Inc., Cerritos, Calif., and JTAG Technologies BV, Eindhoven, the Netherlands, have published the first comprehensive catalog of the Scantest Family of boundary-scan products from the two companies. The 80-page catalog contains hardware and software solutions for users of the IEEE-1149.1 boundary-scan and IEEE-1149.5 MTM test standards. Included are descriptions of scan controllers, digital I/O modules, and software for automated test-vector generation and fault diagnostics. An introductory section includes an overview of boundary-scan technology, the IEEE-1149.1 test bus standard, and its implementation. A discussion of the cost of implementing scan test and the potential savings in time and money also is provided. JN **CIRCLE 936**

APP NOTE SUPPLIES ANSWERS ABOUT ARBS

Although it's titled "Advanced Waveform Creation," an application note from LeCroy Corp., Chestnut Ridge, N.Y., will be helpful for any engineer who must simulate real-world signals to test their designs and products. The note consists of a series of two-page answers to actual questions posed by engineers regarding the use of arbitrary waveform generators. It covers the advanced features today's arbitrary generators use to make complex waveform generation much easier than in the past. Subject headings include precise waveform time shifts, band-limited waveform editing, quadrature signal generation, convolution with the LW420 Wavestation, pulse waveforms, bit jitter tolerance testing, and creating jitter to specification. The note also lists 32 equations that can be used to create specific waveforms. JN **CIRCLE 937**

TERMINAL BLOCKS AND CONNECTORS

A free 44-page catalog from PCD, Peabody, Mass., features a broad line of interconnection products for industrial-control and instrumentation applications. Included is an expanded line of stackable screw-clamp terminal blocks, which offer users a great deal of application flexibility. This third edition of "Connectors for Industrial Electronics" covers pluggable terminal blocks and headers; printed-circuit/terminal locks and barrier blocks; and ZIF (Zero Insertion Force) male and standard edge card connectors. The catalog includes the company's new U.S.-made ELM Stackable Terminal Blocks. They have a reduced seated height and accept an extended wire range of 12-28 AWG, suiting them for applications requiring low-profile terminations. The ELM terminal block family is comprised of two- or three-position screw termination modules that can be interlocked together in secure assemblies without sacrificing pin spacing. CM **CIRCLE 938**

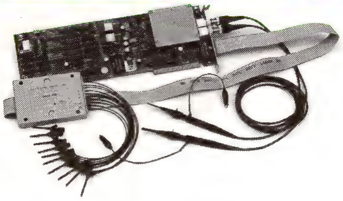
INSTRUMENTATION AND SYSTEM PRODUCTS

Eurotherm Controls, Reston, Va., has a 128-page full-color product catalog describing its full line of instrumentation and system products. The catalog contains five sections: temperature controllers and programmer/controllers; process controllers; power-control products; interface and alarm units; and systems products. Each section begins with a tutorial, applications information, definitions of commonly used terminology, and convenient product selector guides. For ordering purposes, every instrument presented is accompanied by a brief synopsis explaining features and options, a photograph, dimensional information, and the complete product code. CM **CIRCLE 939**

PREMISES INTERCONNECT CENTER FOR STORAGE

Siecor Corp., Hickory, N.C., has product specification literature for its new Premises Interconnect Center (PIC) for fiber protection and storage. The literature describes product features, workstation capabilities, specifications, and ordering information for the PIC. Featuring a modular style that allows for easy expansion and for future growth and reconfiguration, the well-mountable PIC accommodates either 12- or 24-fiber panels and is ideal for interconnection and cross-connection in building entrance terminals, wiring closets, computer rooms, and other controlled environments. All popular connector styles are compatible with the PIC, including simplex and duplex designs: ST compatible, SC, FC, D4, FDDI, SMA, and Biconic. CM **CIRCLE 940**

200MSa/s Digital Oscilloscope

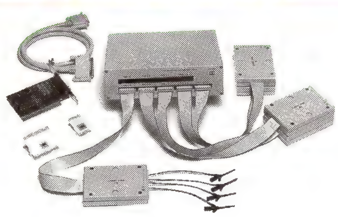


HUGE BUFFER
FAST SAMPLING
SCOPE AND LOGIC ANALYZER
PC-BASED INSTRUMENT
C LIBRARY AVAILABLE
POWERFUL SOFTWARE

- 200 MSa/s Sampling Rate
- up to 128K Samples/Channel
- 2 Analog Channels (2 ch. Oscilloscope)
- 8 Digital Channels (8 ch. Logic Analyzer)
- All 10 channels can be used at same time
- Simultaneous use of all 10 channels
- Cross Triggering of Digital and Analog
- 125 MHz Single Shot Bandwidth

$1799 DSO-28200 (200MSa/s, 4K/Ch)
$2285 DSO-28264 (200MSa/s, 64K/Ch)

400 MHz Logic Analyzer

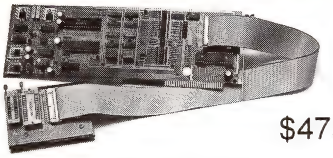


- up to 128 Channels
- up to 400 MHz
- up to 16K Samples/Channel
- Variable Threshold
- 8 External Clocks
- 16 Level Triggering
- Pattern Generator (Option)

$1299 - LA32200 (200 MHz, 32 Ch) Pods &
$1899 - LA32400 (400 MHz, 32 Ch) Software included
Also Available:
$799 - LA12100 (100 MHz, 24 Ch, TTL only)

Universal Programmer

PAL - GAL - MICRO
EPROM - EEPROM - FLASH



$475

Call for full device support list

Free software updates on BBS

Call (201) 808-8990

Link Instruments
369 Passaic Ave, #100, Fairfield, NJ 07004 fax: 808-8786

LINK INSTRUMENTS **CIRCLE 423**

PROTO EXPRESS

Best Value in the World for

Polyimide and FR4
Commercial & Milspec
MULTILAYER PROTOTYPES

1 to 5 day turns □ 1 to 12 layers

5 DAY TURN PRICES FOR FR4 BOARDS

SINGLE SIDED					DOUBLE SIDED					3 & 4 LAYERS				
PIECES		2	5	10	PIECES		2	5	10	PIECES		2	5	10
SQUARE INCH UP TO	15	$233	$311	$389	SQUARE INCH UP TO	15	$292	$389	$487	SQUARE INCH UP TO	15	$639	$851	$1065
	30	264	352	441		30	330	441	552		30	724	965	1207
	60	311	414	519		60	389	519	650		60	853	1135	1420
	90	358	476	608		90	448	597	747		90	980	1305	1632
	120	385	519	649		120	486	649	812		120	1044	1420	1774

5 & 6 LAYERS					7 & 8 LAYERS				
PIECES		2	5	10	PIECES		2	5	10
SQUARE INCH UP TO	15	$787	$1049	$1312	SQUARE INCH UP TO	15	$935	$1247	$1560
	30	891	1189	1487		30	1059	1414	1768
	60	1049	1399	1750		60	1137	1663	2080
	90	1207	1597	2012		90	1434	1912	2391
	120	1311	1750	2187		120	1559	2079	2599

ALL OTHERS - CALL FOR QUOTE

EXTRAS
- Photoplotting
- Testing
- Gold Contacts - $50
- 25% - Below 8 Mil
- Thickness Variation
- SMOBC & LPI - $50

Prices effective January 1, 1993.

Capabilities

- Buried & Blind Vias
- Polyimide Multilayer
- Full body & bondable gold
- Carbon Paste
- Tin nickel burn-in boards
- SMT - SMOBC
- Up to 22 layers
- Impedance control boards
- UL listed

DISCOUNTS: **10%** COD
5% CREDIT CARD SALES

Call Ken Bahl

1108 West Evelyn Avenue
Sunnyvale, California 94086

PHONE: 408/735-7137
FAX: 408/735-1408
MODEM: 408/735-9842

PROTO EXPRESS **CIRCLE 41**

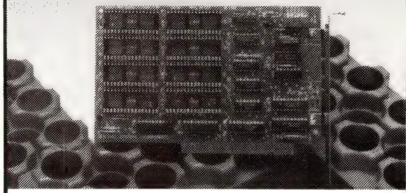
ELECTRONIC DESIGN

DIRECT CONNECTION ADS

New Products/Services
Presented By The Manufacturer.
To Advertise,
Call Kimberly A. Stanger
At 201/393-6080

SOLID STATE DISK

- **Put DOS and Application in EPROM**
- **Allows Diskless Operation**
- **Up to 1&3 MBYTE ROM-DRIVE with 16K Footprint**
- **Promkit Software by Annabooks Available**
- **Flash EPROM Supported**
- **Battery RAM Modules Supportec**
- **Made in USA**



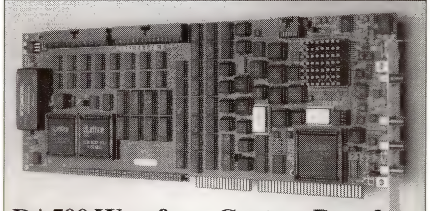
SEALEVEL COMMUNICATIONS & I/O

Sealevel Systems Inc.
PO Box 830
Liberty, SC 29657
803-843-4343

SEA LEVEL SYSTEMS **CIRCLE 4**

---

500 MHZ Real-Time



DA500 Waveform Capture Board

- 500 MHZ 8 bit digitizer
- 200 MB/SEC auxiliary bus
- Memory expandable to 1gigabyte
- 350 MHZ analog bandwidth
- 2 analog input channels
- ISA compatible board

We Supply Solutions! *Call to discuss your application with one of our engineers.*

Signatec

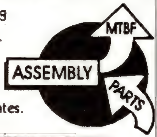
355 N. Sheridan St.• #117
Corona, CA 91720 USA
(909) 734-3001
Fax: (909) 734-4356

SIGNATEC, INC. **CIRCLE 417**

INDUSTRIAL RELIABILITY

The Industrial Reliability Prediction Program (RBC), performs fast and easy reliability predictions of electronic, electro-mechanical, and electrical systems using Bellcore Report TR-NWT-000332.

RBC provides accurate and efficient calculations of steady-state failures and first year infant mortality rates.



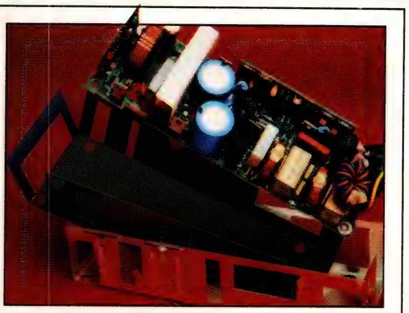
PSI Family of Products
- Reliability • Industrial • Automotive
- Parts Count • Mechanical
- System Reliability • Maintainability
- FMECA • Process FMEA

DEMO PACKAGE AVAILABLE

For a list of Documents Supported
Call 1-800-779-0202,
Code 013359 to receive a direct FAX

PSI
POWERTRONIC SYSTEMS, INC.
13700 Chef Menteur Highway
New Orleans, LA 70129
504-254-0383 FAX 504-254-0393

POWERTRONIC SYSTEMS, INC. **CIRCLE 415**



SAVE MONEY With Lexan® FR700 Film For Barrier Insulation

• UL94 V-0 rated at .010" • High heat resistance of 275°F • Excellent dielectric strength • Easy fabrication–sharp folds, intricate die-cut shapes • Competitively priced • Call for free information: (800) 451-3147

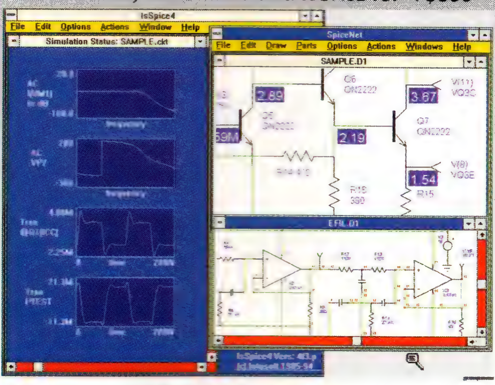
GE Plastics
Structured Products

® Registered Trademark of GE.

GE PLASTICS **CIRCLE 406**

Affordable Analog Simulation

ICAP/4Lite, Schematic and IsSpice for < $600


IsSpice4
File Edit Options Actions Window Help
Simulation Status: SAMPLE.cir
SpiceNet
File Edit Draw Parts Options Actions Windows Help
SAMPLE.D1
EFIL.D1

- **Powerful Simulation Capability**
Simulate all types of designs: Power, ASIC, RF, Mixed Mode, Control Systems, and Mixed Technologies (Electrical, Mechanical, and Physical)
- **IsSpice4, *Interactive SPICE Simulation***
Enhanced SPICE program based on Berkeley **SPICE 3F.2**. Performs AC, DC, transient, and temperature analyses. Includes **"Real Time"** waveform display and Mixed Mode capability. Works with all popular schematic entry systems!
- **UNLIMITED CIRCUIT SIZE**
- **Completely Integrated System**
Systems include Schematic Entry, SPICE Simulation, Extensive Model Libraries (500+ models) and a Waveform Display program. An inexpensive upgrade path to higher performance tools and models is available.
- **Platform and Product Support**
Windows and Windows NT. Intusoft technical Newsletter and Compuserve BBS Forum.

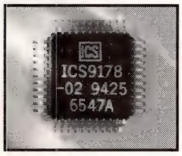
Call or write for your free information and demonstration kit.

- **Affordable Prices - $595**
Includes Full Support and Modeling Service

intusoft
P.O. Box 710 San Pedro,
CA 90733-0710
Tel. 310-833-0710
Fax 310-833-9658

INTUSOFT **CIRCLE 412**

300-MHz CLOCK GENERATOR FOR PowerPC™



From ICS, the leader in frequency timing generation: ICS9178 efficiently and inexpensively handles all clocks required for high-speed PowerPC RISC systems.

- Generates 14 clocks, including two 2X clocks to 300 MHz (for 5V or 5V/3.3V mixed supply) or 200 MHz (3.3V only).
- Offers bus to processor clock that skews less than ± 250 psec.
- Built using 0.8μ low-power, low-cost CMOS process.
- Available as a 44-pin PQFP package.

Integrated Circuit Systems, Inc.
2435 Boulevard of the Generals
Valley Forge PA 19482-0968
1-800-220-3366
Fax: (215) 630-5399

ITEGRATED CIRCIUT SYS. **CIRCLE 408**

IC SYNCS VIDEO, COMPUTER GRAPHICS

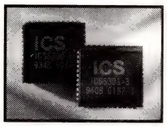
From ICS, the leader in high-performance frequency synthesis: ICS1522 Video Key links video and computer graphics reliably and inexpensively.

- Accepts low-frequency references (down to 15 KHz), synchronizes external video inputs for use in advanced multimedia systems.
- Provides over 24 user-programmable parameters, including pixel frequencies to 230 MHz with differential output, for more flexibility.
- Simplifies design. Complete, low-jitter solution replaces expensive circuitry performing the same functions.

Integrated Circuit Systems, Inc.
2435 Boulevard of the Generals
Valley Forge PA 19482-0968
1-800-220-3366
Fax: (215) 630-5399

INTEGRATED CIRCIUT SYS. **CIRCLE 409**

OFFER GREAT COLOR EASILY, AT LOW COST



From ICS, the leader in graphics timing: ICS5300 and ICS5301 GENDACs combine dual programmable clock generators, 256 x 18-bit RAM and triple 8-bit video DAC in one chip that's less expensive, easier to design with and offers brilliant color.

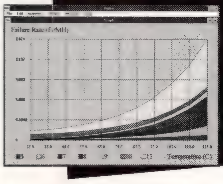
- Delivers speed—up to 135 MHz for 1280 x 1024—for better resolution, more colors, outstanding photo-realistic quality.
- Supports 24-, 16-, 15- and 8-bit color modes.
- Simplifies design. Complete, low-jitter solution replaces complicated circuitry performing the same functions.

Integrated Circuit Systems, Inc.
2435 Boulevard of the Generals
Valley Forge PA 19482-0968
1-800-220-3366
Fax: (215) 630-5399

INTEGRATED CIRCIUT SYS. **CIRCLE 410**

Relex

Reliability Software



Mac! DOS! Windows!

Relex Reliability Software, long known for its power and flexibility, is now available for Windows, the Mac, and DOS! With features such as a powerful CAD interface, system modeling, impressive graphics, and unmatched user-friendliness, Relex is the ultimate, intuitive solution!

• MIL-HDBK-217 • Bellcore • Parts Count •
• Mechanical • CNET • FMECA • more •

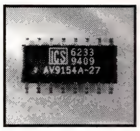
Call 410-788-9000 Today For a Free Demo!

INNOVATIVE SOFTWARE DESIGNS, INC.

Two English Elm Court
Baltimore, MD 21228 USA
410-788-9000
FAX 410-788-9001

NNOVATIVE SOFTWARE DESIGN **CIRCLE 407**

LOW-COST FTG PERFECT FOR PENTIUM™

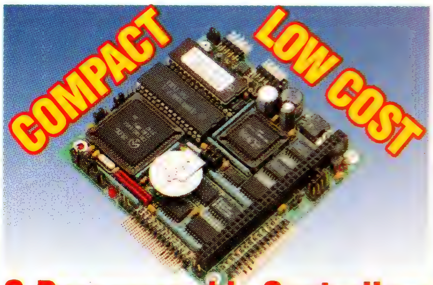


From ICS, the leader in frequency timing generation: AV9154A-27, a low-cost 16-pin frequency generator using 0.8μ technology and the latest phase-locked loop architecture, giving it the performance necessary for Pentium systems.

- Runs up to 66 MHz at 3.3V, perfect for laptop and handheld designs.
- Offers glitch-free clock with stop and slow-down abilities.
- Meets Intel's jitter and skew specifications with the industry's lowest jitter signals (± 250 psec).

Integrated Circuit Systems, Inc.
2435 Boulevard of the Generals
Valley Forge PA 19482-0968
1-800-220-3366
Fax: (215) 630-5399

INTERGRATED CIRCUIT SYS., INC. **CIRCLE 411**



C-Programmable Controllers

Use our controller as the brains of your next control, test or data acquisition project. From $149 qty one. Features I/O to 400 lines, ADC, DAC, RS232/RS485, printer port, battery-backed clock and RAM, keypads, LCDs, enclosures and more! Our simple, yet powerful, Dynamic C™ makes programming a snap!

24-Hr AutoFAX:
916.753.0618
Call from *your* FAX.
Request catalog 18.

1724 Picasso Ave.
Davis, CA 95616
916.757.3737
916.753.5141 FAX

Z-WORLD **CIRCLE 419**

DIRECT CONNECTION ADS

SPRINT PLUS48

Universal Device Programmer

Call (800) 722-4122
FAX (206) 883-8601

- High Quality Universal Programmer you can afford to own.
- Programming support for over 2500 devices.
- PAL, GAL, PLD, EPLD, FPGA, EPROM, PROM, Micro.
- 48 Universal (NOT TTL) pindrivers.
- Connects to the printer port of your PC.
- Updates via BBS and/or floppy disk.
- Local service and support.

SMS
SMS North America, Inc.

SMS NORTH AMERICA **CIRCLE 421**

ChipLab™

Simple, personal
device programming

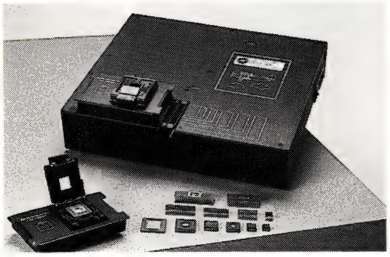
- **ChipLab™** makes device selection and programming fast and easy with its Windows™-like user interface
- Extensive on-line help
- Programs more than 2000 PLDs, PROMs, EPROMs, EEPROMs, and MCUs
- $895 (32-pin version) or $1495 (48-pin version)

To order call:
Authorized Distributors
JDR Microdevices 1-800-538-5000
Promark Technology West 1-800-227-3345
or call:
Data I/O Corporation 1-800-332-8246 Ext. 904

DATA I/O

DATA I/O **CIRCLE 403**

Advin



PILOT-U84 Universal Programmer

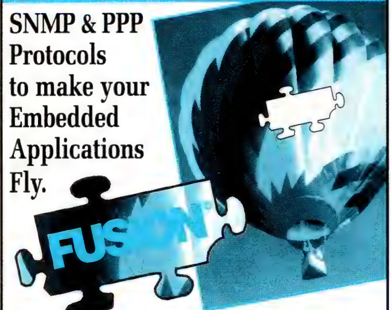
The Leader in *New* FPGA Support

- Altera MAX 7064, 7128 • Xilinx 1736D,1765D etc
- Intel FX-740, FX-780; 87C196 KD,KR,JR,MC etc
- Moto 68HC711D3, E9; 68HC705 C8,C9,P9 etc
- WSI PSD-4XX,-5XX,PAC,SAM • Atmel 29C040 etc
- AMD MACH435, 29F040, 16R8-4 • Lattice pLSI etc
- All packages to 256-pin: PLCC,PGA,QFP,TQFP,SOIC

800-627-2456 FAX: (408) 736-2503

ADVIN SYSTEMS **CIRCLE 401**

TCP/IP
DEVELOPER'S KIT



SNMP & PPP Protocols to make your Embedded Applications Fly.

1-800-541-9508
805-484-2128 • FAX 805-484-3929

Pacific Softworks

Highly Portable INTERNET Protocols added to your System Design.

ROYALTY-FREE OPTIONS

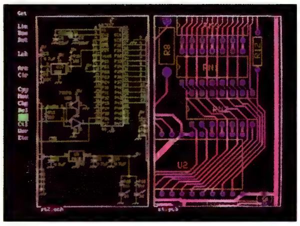
PACIFIC SOFTWORKS **CIRCLE 414**

ADVERTISE WITH US!

Advertise in **ELECTRONIC DESIGN** and see how quickly you'll be turned on!

HiWIRE II

Schematic and PCB Software

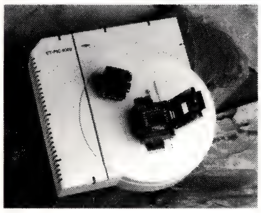


With support for expanded and extended memory, HiWIRE II can handle your most demanding schematic and PCB designs. The unique HiWIRE II editor allows you to display and edit schematics and PCBs simultaneously, using the same commands for each. HiWIRE II is $995 and is guaranteed.

WINTEK®
Wintek Corporation
1801 South Street
Lafayette, IN 47904

(800) 742-6809 or (317) 448-1903

WINTEK **CIRCLE 418**



10% off all adapters ordered with programmer

PC-based Programmer for over 2000 Devices

- ✓Program CMOS, PLDs, FPGAs, bipolar and MCUs
- ✓Semiconductor manufacturer approved algorithms
- ✓Over 400 adapters available from stock
- ✓Immediate device list updates via BBS 408-982-9044
- ✓Ask about our trade-in discount offer
- ✓Same day delivery

ET™

EMULATION TECHNOLOGY, INC.
800.995.4381

EMULATION TECH. **CIRCLE 405**

YOUR AD HERE

Here's all you have to do:

- Send a B/W or 4C glossy photo.
- Include 13 lines of copy.
  (37 characters per line)
- Write a headline of 32 characters or less.

We do all the rest.
No production charges.

We also accept camera-ready art.
Ad size $2^3/_{16}''$ wide × 3″ deep.

ADVERTISE WITH US!

Advertise in ELECTRONIC DESIGN and see how quickly you'll be turned on!

Schematic ■
PCB layout ■
Autoroute ■
PLD design ■

Your Choice for EDA Solutions

TangoPRO™ for WINDOWS

Tango® for DOS

Helping good ideas become great products

Call for your free, full-function demo
800 488-0680
ACCEL Technologies, Inc.

ACCEL TECH. CIRCLE 400

Emulator
8051/68HC11/Z80
42 Variants Supported

Only $995

- Symbolic and source level debugging
- Windowed user interface
- Free single board computer with purchase
- Works with your compiler
- 30-day money back guarantee
- Call 1-800-847-1998

Cactus Logic
Cactus Logic
180 North Vinedo Ave., Pasadena, CA 91107
Tel: 818-796-1773
Fax: 818-796-6011

CACTUS LOGIC CIRCLE 424

NoiseKen®

COMPUTER CONTROLLED SUPERBFUNCTION
ELECTROSTATIC DISCHARGE SIMULATOR
MODEL ESS-200AX

CONFORMING TO IEC PUB.801-2

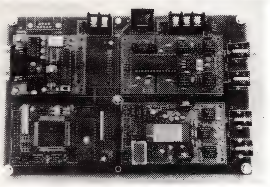
- OUTPUT VOLTAGE 0.2~30.0kV
- OPERATING MODES IEC SEVERITY LEVEL MANUAL SWEEP PROGRAM

For all your EMI/EMC/IEC Pub.801 series needs, please contact
U.S.A. WATAHAN NOHARA INTERNATIONAL, INC.
TEL(800)366-3515

ESD/IMPULSE NOISE/VOLTAGE DIP/LIGHTNING SURGE

ISE LABORATORY CIRCLE 413

BNK MightyMight™ DSP Systems
"FEEL THE POWER"™ - Powerful & Inexpensive



MM56001 - Low Cost DSP56001 PC-Based Development System
Use as Powerful DSP development tool & DSP controller in embedded systems. Comes complete with DSP module (Motorola DSP56001 processor - 33MHz/16.5 MIPS), RS232 host PC interface, 96 kbytes of zero wait state SRAM, 32 kbytes EPROM socket, debugger, 'C' utility library, manual, power adapter and cables. US$ 299.00

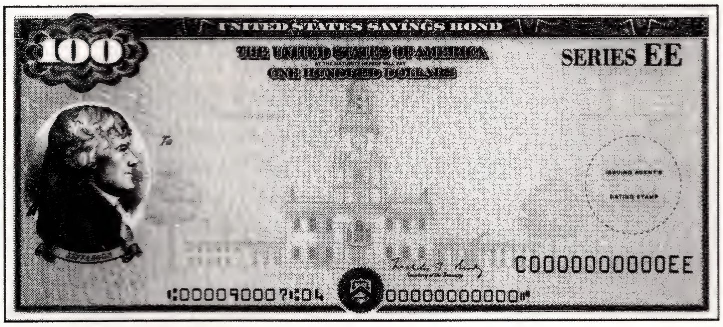
MM20AD - 20-Bit Analog-Digital Converter Module	US$ 199.00
MM20DA - 20-Bit Digital-Analog Converter Module	US$ 199.00
MM18AD - 18-Bit Analog-Digital Converter Module	US$ 149.00
MMMB - Low Cost Motherboards for BNK Modules	US$ 79.00 +
MMSA - Spectrum Analyzer Software for MM System (Windows Based Software)	US$ 99.00

*56001 'C' compiler, assembler and simulator are sold separately.

BNK Electronics, Inc. TEL-(201) 894-5905
460 Sylvan Avenue FAX-(201) 894-5736
Englewood Cliffs, NJ 07632 USA

DSP SOLUTIONS --- DSP SOLUTIONS --- DSP SOLUTIONS

IK ELECTRONICS CIRCLE 425



This Is A Happy Retirement

It's the peace of mind you get knowing you have saved for the future. It's a U.S. Savings Bond. With just a little from each paycheck, you can invest in Bonds through the Payroll Savings Plan where you work. And they will keep earning interest for up to 30 years. Make an investment in your future with U.S. Savings Bonds today. Ask your employer for details.

U.S. Savings Bonds

A public service of this publication.

BACH, BEETHOVEN, BOSE.

True innovation doesn't happen every day.

When you listen to a BOSE sound system for the first time, you'll probably hear something you've never heard before. A depth, a richness, a suggestion of live performance that no other system surpasses. Because no other system utilizes BOSE' technology. That's what true innovation is really all about. Making it better, making it first, and making it to last. The following engineering opportunities are currently available; a devotion to innovation is required for all.

SENIOR ENGINEERING MANAGER

You will be managing a multidisciplinary team whose mission is to deliver cost-effective, manufacturable electronic products. You will define project development strategies and tasks, minimize design challenges, and ensure that development schedules and budgets are met. You'll also plan, schedule, coordinate, and conduct detailed concept and development phases of electronic system programs. This position requires a hands-on professional who has a BSEE/MSEE and at least 5 years' experience managing multidisciplinary product development teams. You should have a proven track record directing projects, overseeing budgets and introducing new products into manufacturing. Experience performing analog and digital hardware design is essential. A knowledge of RF, power supplies, DSP and/or microcontroller applications is required.

SENIOR SOFTWARE/MICROCONTROLLER ENGINEER

Design and implementation of systems using microcontrollers and supporting digital hardware will be among your challenges as a member of our OEM Electronics Group. You will also be designing low level assembly language device drivers, and C language control firmware and software. You'll need experience performing cost/performance comparisons involving 8/16 bit microcontrollers, and working knowledge of software revision control techniques. BS/MS in EE or CS and a background in digital logic and mass production design is a must; a familiarity with programmable logic is a plus.

ELECTRONIC PRODUCT DEVELOPMENT ENGINEER

Working in a cross-functional team, you'll handle the development of OEM automotive audio electronics from concept to production. Your work will include creating circuit designs for audio signal processing and power amplifiers, developing PC board circuitry, testing and evaluating prototypes, generating documentation, and providing manufacturing development. You should have an MSEE or equivalent and 2-5 years' experience in a related field, including work in analog circuit design with a focus on manufacturing. A background in RF, microprocessors, and/or digital signal processing (DSP) is necessary.

MECHANICAL PROJECT ENGINEER

You will be responsible for the mechanical content of new OEM products. This means directing designers, performing engineering analyses, working with customers, and conducting research into specific problem areas. You will also provide analytical and design review support for a range of other programs. This position requires a BSME/MSME, at least 8 years of experience, and a demonstrated ability to lead mechanical design activities, including direct customer interactions. A familiarity with test equipment (accelerometers, spectrum analyzers, etc.) is necessary. You must possess substantial FEA experience including the skills to perform complicated analyses of fluid mechanics, heat transfers, stresses and vibrations. A background in plastics design and tooling, basic acoustics and electronics, and a 3D CAD tool (UG,SDRC, ARIES, etc.) is desirable.

For consideration, please forward your resume to: BOSE Corporation, Heather Sweeney, The Mountain, Framingham, MA 01701-9168. An equal opportunity employer.

BOSE®

Better sound through research.

BUSINESS SERVICES

Attention Electronic Designers!

Our clients are searching for new electronic products to bring onto the market; patented or patentable for licensing or purchase.

Send synopsis or description to:

LRN Associates
6821 Vianda Court
Carlsbad, CA 92009
Attn: Innov. Eng.

Your reply will be held in confidence; no proprietary information, please.

SURPLUS INVENTORY

SURPLUS SALE

200,000 WALL TRANSFORMERS

7.5 VDC	50 MA	.85
12 VDC	100 MA	1.10
12 VDC	500 MA	1.75
12 VDC	800 MA	2.10
14 VAC	500 MA	1.75
16 VAC	1.25 A	2.95

Min 1000/type - - Call for other types

SURPLUS TRADERS

PO Box 276,
Alburg, Vt. 05440
Tel: 514-739-9328
Fax: 514-345-8303

FREE CATALOG!

EMPLOYMENT OPPORTUNITIES

TECHNICAL SOFTWARE PROFESSIONALS...

SEEKING REWARDING TECHNICAL CHALLENGES?

JOIN THE SOFTWARE DEVELOPER OF CHOICE!

Keane is a nationwide $350MM software technology and development firm whose rapid growth has made it one of the largest firms of its type in the country. We've been named one of the best managed firms in the country by *Business Week* and *Forbes* magazines. Stay ahead of the technology curve by joining forces with a market leader!

SOFTWARE ENGINEERING

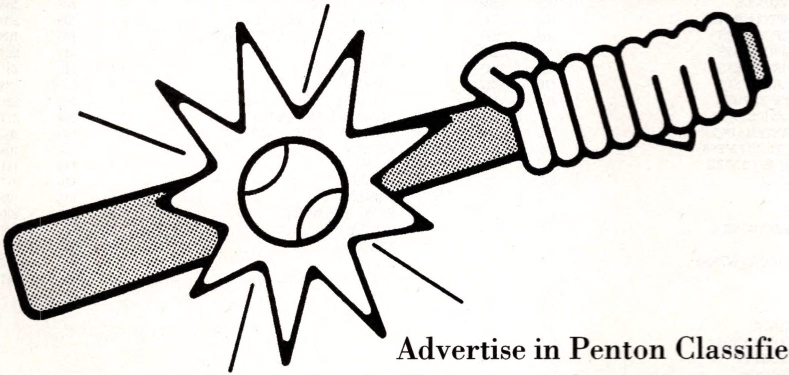
Exceptional **Software Engineers** are in demand for a variety of applications and environments in Wisconsin, Illinois & Ohio. All need strong, hands-on UNIX/'C'/C++ skills, combined with **structured development**, **networking** and/or **testing/validation** experience.

Individuals should have degrees in either Computer Science or Electrical Engineering, at least 2-4 solid years of experience in software development, and excellent communications skills. Please indicate any geographical preference.

KEANE

Keane offers methodology, project management and technical training, competitive salaries and comprehensive benefits. Fax your resume to (414) 797-4998, or send it to Keane, Inc., Attn: Glen Gilchrist, 400 N. Executive Drive, Suite 315, Brookfield, WI 53005. An equal opportunity employer. Additional opportunities available nationwide.

Strike out your competition!



Advertise in Penton Classifieds!
For more information contact:
Lois Walsh
(216) 696-7000 ext.2359

PROFESSIONAL SERVICES

PRODUCT ENGINEERING & MFG., INC.

Over 25 Years Experience in Complete Mechanical Services

- **Industrial Design & Rendering**
- **Enclosure Design**
- **Mechanism Design**
- **Reverse Engineering**
- **Product Evaluation**
- **Prototyping**

From hand held Plastic Products...
.........Too Complete Machines

CALL FOR BROCHURE
Virginia 1-800-848-2553

ELECTRONIC DESIGN

Chairman and CEO: Sal F. Marino
President and COO: Daniel J. Ramella
President, Electronics Group: James D. Atherton

Advertising Sales Staff

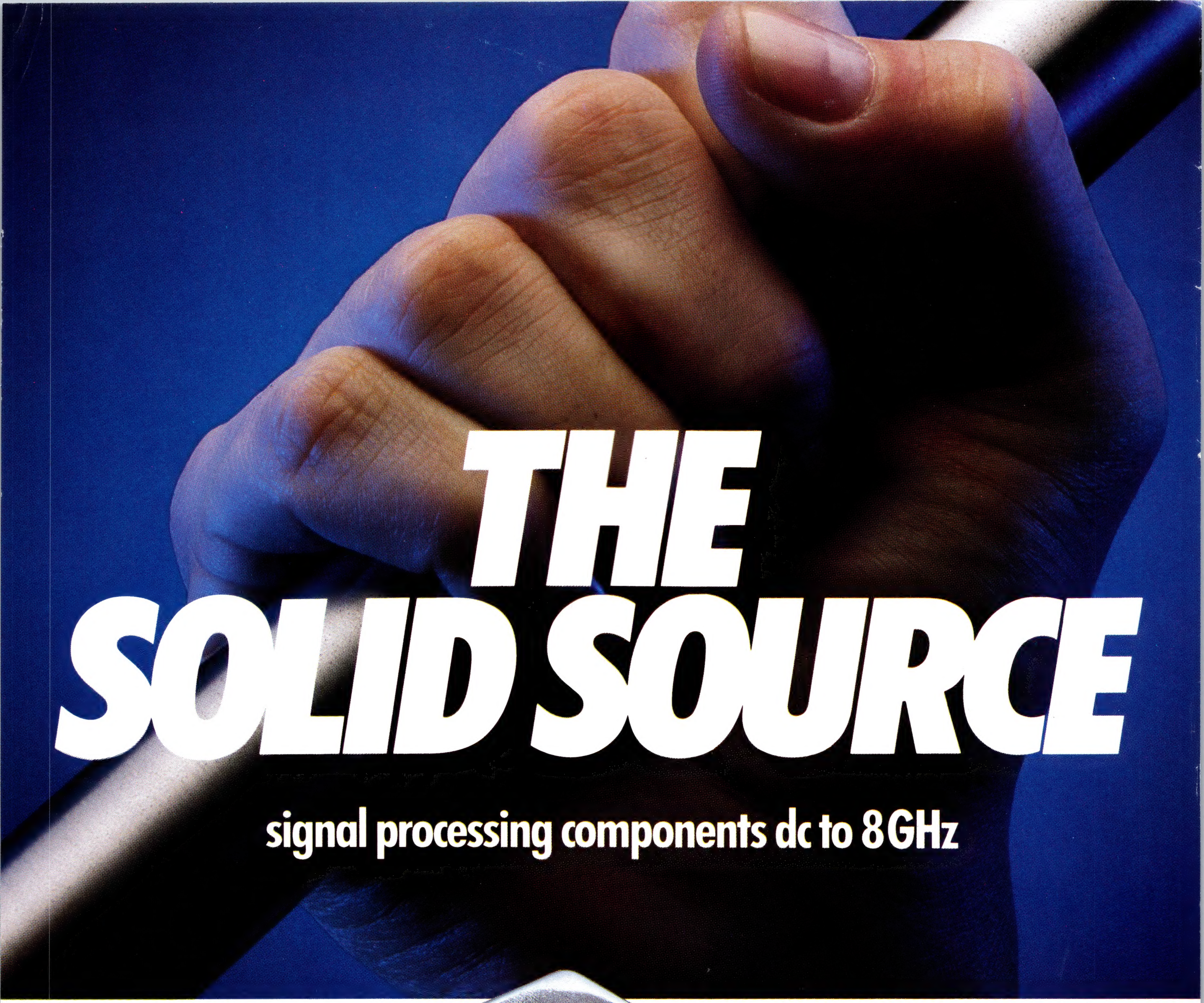
Publisher: John R. Carroll
Hasbrouck Heights, NJ; (201) 393-6060
National Sales Manager: Russ Gerches
Hasbrouck Heights, NJ; (201) 393-6045
General Manager, European Operations: John Allen
36 The Green, South Bar Banbury, Oxford 0X16 9AE,
U.K. Phone: 44 (0)295-271003 FAX: 44 (0)295-272801
Hasbrouck Heights: Judith L. Miller, Jami Radow
Sales Asst.: Tina Edwards
611 Route #46 West, Hasbrouck Heights, NJ 07604;
Phone: (201) 393-6060 TWX: 710-990-5071
Boston & Eastern Canada: Ric Wasley
400 Fifth Ave., Waltham, MA 02154;
Phone: (617) 890-0891 FAX: (617) 890-6131
Colorado: Lou Demeter (408) 441-0550
Chicago/Midwest: Mark Kearney
Sales Assistant: Susan Johnson
180 N. Stetson Ave., Suite 2525 Chicago, IL 60601;
(312) 861-0880 FAX: (312) 861-0874
Arizona: James Theriault (408) 441-0550
Los Angeles/Orange County/San Diego: Ian Hill
Sales Asst: Patti Kelly
16255 Ventura Blvd., Suite 200 Encino, CA 91436;
(818) 990-9000 FAX: (818) 905-1206
San Jose:
Jeff Hoopes, Lou Demeter, James Theriault
Sales Administrator: Sarena Owens
2025 Gateway Pl., Suite 354 San Jose, CA 95110;
(408) 441-0550 FAX: (408) 441-6052 or (408) 441-7336
Pacific N.W. & Western Canada: Jeff Hoopes (408) 441-0550
Texas/Southeast: Bill Yarborough
12201 Merrit Dr., Suite 220, Dallas, TX 75251;
(214) 661-5576 FAX: (214) 661-5573
Direct Connection Ads Sales Representatives:
Kim Stanger (201) 393-6080
Recruitment/Classified: Lois Walsh
(216) 696-7000, ext. 2359 Fax: 216-696-8207
Netherlands, Belgium: Peter Sanders, S.I.P.A.S.
Rechtestraat 58 1483 Be De Ryp, Holland
Phone: 312 997 1303 Fax: 312 997 1500
France: Fabio Lancellotti
Defense & Communication
10 Rue St. Jean 75017 Paris France
Phone: 33-142940244 FAX: 33-143872729
Spain/Portugal: Francoise Schmitt
Publi Schmitt General Yague 8,
Apt. 4C, 28020 Madrid, Spain
Phone: 34-1-5554208 FAX: 34-1-5551450
Scandinavia: Paul Barrett
I.M.P. Hartswood Media,
Portfolio Business Centre
161-165 Greenwich High Road,
London SE10 8JA, U.K.
Phone: 44-81-293-0380 FAX: 44-81-858-9584
Germany, Austria, Switzerland: Friedrich Anacker
InterMedia Partners GmbH
Deutscher Ring 40, 42327 Wuppertal, Germany
Phone: 49 202 711 091 Fax: 49 202 712 431
Hong Kong: Tom Gorman,
China Consultant Intl.
Guardian Hse, Ste 905
32 Oi Kwan Road, Happy Valley, Hong Kong
Phone: 852 833 2181 FAX: 852 834 5620
Israel: Igal Elan, Elan Marketing Group
22 Daphna St., Tel Aviv, Israel
Phone: 972-3-6952967 FAX: 972-3-268020
Toll Free in Israel only: 177-022-1331
Italy: Cesare Casiraghi, Casiraghi Cesare, S.A.S.
Via Cardano 81, 22100 Como, Italy
Phone: 39 31 536 003 FAX: 39 31 536 007
Japan: Hirokazu Morita,
Japan Advertising Communications
Shiba NK Building
3-22-7 Shiba, Minato-ku, Tokyo 105, Japan
Phone: 81-3-5476-0711 Fax: 81 3 5476 0794
Korea: Young Sang Jo, Business Communications Inc.
K.P.O. Box 1916, Midopa Building 146, Dangju-Dong,
Chongo-Ku, Seoul, Korea
Phone: 011-82-2-739-7840 FAX: 011-82-2-732-3662
Taiwan: Daniel Cheng, Vice President
Ken Kieke, Managing Editor United Design & Publications, Inc. No. 311 Nanking E. Rd., Sec. 3, 8th Floor
Taipei, Taiwan R.O.C.
Phone: 011-886-2-7184407 FAX: 011-886-2-7125591
United Kingdom: John Maycock
Huttons Buildings, 146 West St. Sheffield, England S14ES
Phone: 44 742 759 186 44 742 781 650

INDEX OF ADVERTISERS

ADVERTISER	READER SERVICE	PAGE NUMBER
3M	256	77
AAVID ENGINEERING INC.	174,175	117
AAVID ENGINEERING INC.	171,172	115
AAVID ENGINEERING INC.	170	113
ACCEL TECHNOLOGIES	400	249
ACTEL	275	43
ADVANCED MICRO DEVICES	---	2-3
ADVIN SYSTEMS	401	248
ALLIED ELECTRONICS	228	235
ALTERA CORPORATION	150	124
AMI SEMICONDUCTORS	166	91
AMP	194	13
AMPLIFIER RESEARCH	241	213
ANALOG DEVICES INC.	169	80a-d
ANALOGIC CORPORATION	243	230
ANCOT CORPORATION	80	10
APEX	81,82	1
APPLIED MICROSYSTEMS	203	167
ARIEL CORPORATION	162	143
ASTEC AMERICA	233,276	227*
ASTEC AMERICA	232	226*
AT&T	164	47*
ATLANTA SIGNAL PROCESSORS	201	188
BLILEY ELECTRIC COMPANY	253	170*
BNK ELECTRONICS	425	249
BURR-BROWN	83,84	9**
BURR-BROWN	226,227	149
BURR-BROWN	208,209	66-67
C&K COMPONENTS INC.	85	203
CACTUS LOGIC	424	249
CAPILANO COMPUTING	422	248*
CHECKMATE SYSTEMS	86	166
CHRONOLOGIC SIMULATION	259	6
CHRONOLOGY CORPORATION	237	241
CLASSIFIED	---	250-251
COILCRAFT	196	96f
COMLINEAR CORPORATION	260,280	39
COMPASS DESIGN	281	139
COOPER & CHYAN TECHNOLOGY	87	211
CRYSTAL SEMICONDUCTOR	231	237
CSEM	279	87**
CYBERNETIC MICROSYSTEMS	183	16
CYPRESS SEMICONDUCTOR	---	cov4
DALLAS SEMICONDUCTOR	167	95
DATA I/O	403	248
DELKER CORPORATION	88	210
DIGI-KEY	89	9*
DIGITAL EQUIPMENT CORP.	---	121
DIVERSIFIED TECHNOLOGY	90	56-57
DIVERSIFIED TECHNOLOGY	91	59
ELANTEC	264	104
EMULATION TECHNOLOGY	405	248
EMULATION TECHNOLOGY	404	248*
EPSON AMERICA	168	96c*
EPSON SEMICONDUCTOR	236	195**
FORCE COMPUTERS INC.	184,185	162-163
FREQUENCY ELECTRONICS	188	214
GE PLASTICS	406	247
HAMILTON HALLMARK	205	158-159
HARRIS SEMICONDUCTOR	206	107
HARTING ELEKTRONIK INC.	148	229
HEWLETT PACKARD	258	44
HEWLETT-PACKARD	160	174-175
HEWLETT-PACKARD	159	200-201*
HEWLETT-PACKARD	92	177
HITEX-SYSTEMENTWICKLUNG	195	200**
HYUNDAI	200	132-133
HYUNDAI ELECTRONICS	151	130-131*
HYUNDAI ELECTRONICS	93	130-131**
I-TECH CORPORATION	221,222	171*
IBM	155	70-71
INFORMATION HANDLING SERV	191	101
INNOVATIVE SOFTWARE	407	247
INSIGHT ELECTRONICS	265	103*
INSTRUMENT SPECIALTIES	163	73
INTEGRATED CIRCUIT SYS.	408	247
INTEGRATED CIRCUIT SYS.	94	182
INTEGRATED CIRCUIT SYS.	411	247
INTEGRATED CIRCUIT SYS.	410	247
INTEGRATED CIRCUIT SYS.	409	247
INTEGRATED DEVICE TECH.	---	148
INTEGRATED SYSTEMS INC.	190	182
INTERACTIVE CIRCUIT & SYS	189	221*
INTERNATIONAL RECTIFIER	95	26
INTERNATIONAL TV	235	119
INTUSOFT	412	247
INTUSOFT	412	247
ITT POMONA ELECTRONICS	187	218
KEPCO INC.	96	62
KEYSTONE CARBON COMPANY	97	20
KILOVAC	248,249	89
KNURR	98	114
LAMBDA	157	96a*
LAMBDA QUALIDYNE	99	161*
LATTICE SEMICONDUCTOR	100	116
LECROY CORPORATION	165	146
LINEAR TECHNOLOGY	101	176
LINK COMPUTER GRAPHICS	423	246
BURR-BROWN	.282, 283	78-79
LORIN INDUSTRIES	161	216
LUMEX OPTO/COMPONENTS	102	225
MATH WORKS	104	205
MATH WORKS	103	157
MENTOR GRAPHICS	204	152
MERITEC	105,106	219
MF ELECTRONICS	220	12
MICREL SEMICONDUCTOR	229	134

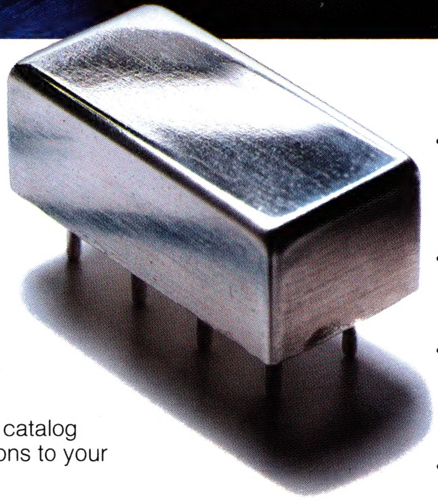
ADVERTISER	READER SERVICE	PAGE NUMB
MICRO NETWORKS	109	8
MICRO POWER SYSTEMS	270	185
MICROCHIP TECHNOLOGY	110	202
MICRON SEMICONDUCTOR	111	55
MINI-CIRCUITS	116	137
MINI-CIRCUITS	115	17
MINI-CIRCUITS	114	4
MINI-CIRCUITS	113	cov3
MINI-CIRCUITS	112	28-29
MISSION RESEARCH	257	10
MITSUBISHI ELECTRONICS	182	96d-e*
MOTOROLA	---	65
MOTOROLA INC.	119	187
MOTOROLA SEMICONDUCTOR	---	123
MUNCHENER MESSE	120	80**
MURATA ELECTRONICS	177	173
NATIONAL HYBRID INC.	245	21
NATIONAL INSTRUMENTS	121,179	14-15
NATIONAL SEMICONDUCTOR	---	144-145
NATIONAL SEMICONDUCTOR	---	40-41
NATIONAL SEMICONDUCTOR	---	82-83
NEC CORPORATION	123	190-191
NEC CORPORATION	122	223
NEC ELECTRONICS	255	96g*
NEC ELECTRONICS INC.	261	207*
NJR	197	150
NKK SWITCHES	---	193
NOHAU CORPORATION	124	99
NOISE LABORATORY	413	249
OKI ELECTRIC INDUSTRY	125	37**
OKI SEMICONDUCTOR	274	96b*
ORCAD	192	cov2
ORION INSTRUMENTS INC.	202	164
PACIFIC SOFTWORKS	414	248
PHILIPS SEMICONDUCTORS	181	69
PICO ELECTRONICS	247	128
PICO ELECTRONICS	247	181
POWER ONE INC.	127	32
POWERTRONIC SYSTEMS INC.	415	246
PROTO EXPRESS	416	246
PROTO EXPRESS	416	246
QUAD DESIGN	156	194
QUALITY SEMICONDUCTOR	234	169
RAMTRON CORPORATION	128	61
RAYTHEON	180	84
RO ASSOCIATES	238	243
ROHM CORPORATION	186	96h
SAMSUNG ELECTRONICS	129	50-51**
SAMSUNG SEMICONDUCTOR	244	18-19*
SEA LEVEL SYSTEMS	420	246
SHARP MICROELECTRONICS	149	34-35
SIEMENS	130	18-19**
SIEMENS COMPONENTS	152,153	37*
SIGNAL PROCESSING GROUP	242	75
SIGNATEC	417	246
SILICON SYSTEMS INC.	154	212
SMART MODULAR	131	155
SMS NORTH AMERICA	421	248
SMS NORTH AMERICA	421	248
SONY SEMICONDUCTOR	132	47**
SONY SEMICONDUCTOR	158	22-23*
SPECTRUM SOFTWARE	198	231
SPELLMAN HIGH VOLTAGE	230	222
STANFORD RESEARCH SYSTEMS	133	215
SUMMIT DESIGN	262	224
SYNOPSYS/LOGIC MODELING	---	49
TEMIC	---	11
TEXAS INSTRUMENTS	135	197*
TEXAS INSTRUMENTS	134	92-93
TEXAS INSTRUMENTS	---	128a-b
TEXAS INSTRUMENTS	137	129
TEXAS INSTRUMENTS	136	24-25*
THEMIS COMPUTER	199	233
THOMSON-CSF	138	186**
THORDARSON-MEISSNER	139	220*
TORONTO MICROELECTRONICS	193	168
TOSHIBA	141	22**
TOSHIBA	140	23**
TOSHIBA	239,240	126-127
ULTIMATE TECHNOLOGY	142	228
ULTRALIFE BATTERIES	225	217
VECTRON LABORATORIES	143	204
VICOR	---	109
VICOR	144	111
VIEWLOGIC	146	87*
VIEWLOGIC	145	199
WICKMANN-WERKE	147	170**
WINTEK	418	248
XICOR INC.	254	31
XILINX	178	52-53
Z-WORLD ENGINEERING	419	247

DOMESTIC ONLY *
INTERNATIONAL ONLY **



THE SOLID SOURCE

signal processing components dc to 8GHz



n today's tough competitive military and commercial markets, Mini-Circuits provides you hat extra edge. From your initial design to ull-scale production, we offer total support to satisfy or exceed your specific requirements.

WIDEST SELECTION OF COMPONENTS 14 product lines with more than 1,000 off-the-shelf atalog models.

EXTENSIVE DATABASE actual performance data on all catalog items plus 5,000 custom models.

STRONG APPLICATIONS SUPPORT an engineering team ready to recommend optimum catalog models, discuss custom designs, and provide solutions to your pecific needs.

ONE-WEEK SHIPMENT GUARANTEE catalog items will be shipped in one week or less or we'll deduct 1% each day we're late.

- UNRIVALED QUALITY statistical process control with 4.5-sigma repeatability on most models, 5-year guarantee on all Ultra-Rel® mixers.
- UNMATCHED PRICES often thirty to fifty percent lower than the competition.
- HIGH-VOLUME CAPABILITY worldwide manufacturing facilities to supply large-quantity production needs on short notice.
- CONSISTENT NEW PRODUCT DEVELOPMENT to meet our obligation to support your future designs.

MIXERS • POWER SPLITTER/COMBINERS • AMPLIFIERS • ELECTRONIC ATTENUATORS • DIGITAL ATTENUATORS • ATTENUATORS/TERMINATIONS • FILTERS DIRECTIONAL COUPLERS • RF TRANSFORMERS • I&Q/QPSK MODULATORS • PHASE DETECTORS • FREQUENCY DOUBLERS • LIMITERS • SWITCHES/DRIVERS

Mini-Circuits®

P.O Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

or detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.

READER SERVICE 113

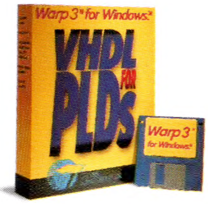
F138 REV.C

GET THE POWER AND THE GLORY.

AND BRING A MORE ENLIGHTENED APPROACH TO PROGRAMMABLE LOGIC.

Here's a revelation for everyone designing with CPLDs and FPGAs.

Warp3™ is the easiest way into VHDL and the fastest design path for high-density programmable logic: from creation through optimization. *Warp3* is based on ViewLogic's™ highest-end Powerview™ and Workview Plus™ graphical environment for Sun and PC platforms. Now you can reevaluate designs in minutes–not hours– with automatic place and route and fitting. Enjoy full timing simulation, mixed mode design entry and schematic capture. Designs can be targeted to Cypress's UltraLogic™ family of high-performance pASIC380 FPGAs and high-density FLASH370 CPLDs, or to alternate devices without modification. Try it for yourself. And see the light.



For a free demo disk and brochure call in Europe: (32) 2-652-0270, ext 119*, Dept. C3H. In Asia: fax your request to 1-415-940-4337*, Dept C3H.

Or contact us via Europe and Asia fax and telephone numbers listed below. *The international operator can give you your country's specific access code.

ULTRA LOGIC

Europe: Fax (32) 2-652-1504. Telephone Hong Kong: (852) 710-8121. India: (812) 566-630 x-3808. Japan: (81) 423-69-82-11. Korea: (82) 2-576-2111 or (82) 2-888-2858. Singapore: (65) 294-8389. Taiwan: (886) 2-820-53-53. *Warp* and UltraLogic are trademarks of Cypress Semiconductor © 1994 Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134 Phone 1-408-943-2600.

CYPRESS